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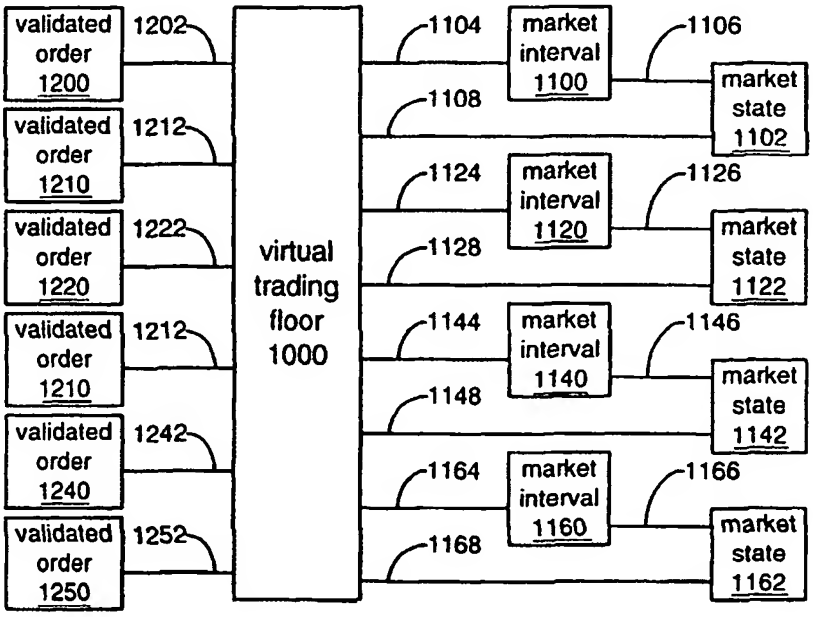
(54) Title: THE VIRTUAL TRADING FLOOR FOR TRADING FUNGIBLE, EPHEMERAL COMMODITIES INCLUDING ELECTRIC ENERGY



(57) Abstract: Certain embodiments include a method and apparatus for trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network each containing a node collection of at least two nodes. The method includes maintaining a market interval collection of market intervals and maintaining a validated order collection of validated orders, each with an associated market interval. Each market interval contains a product type, location and at least one time interval.

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THE VIRTUAL TRADING FLOOR FOR TRADING FUNGIBLE, EPHEMERAL COMMODITIES INCLUDING ELECTRIC ENERGY

Technical field

This invention relates to trading of ephemeral, fungible commodities with regards to trading electrical power as applied to grids of one or more AC power networks.

Background Art

As used herein, a fungible commodity will refer to a commodity traded strictly in terms of the quantity of that commodity. No single unit of a fungible commodity is distinguishable from another unit of that commodity. A kilowatt-hour of 60 Hz AC power delivered on a power line is not distinguishable from another kilowatt-hour delivered at the same time to the same place on the same line. An ephemeral, fungible commodity is a fungible commodity whose existence is extremely short-lived. Electrical power generation, network bandwidth, seats on an airplane and entry slots onto a freeway during rush hour are all examples of fungible commodities which exist but for a short duration of time. In contradistinction, starting lots in an assembly line produce tangible results, which may differ widely in content, thus showing an example of an ephemeral, non-fungible commodity.

Ever since the invention of AC power technology, this and many other countries have benefited from the ability to share the use of AC electrical power across great distances. This AC power technology has proven to be of enormous value. However, the management and control of AC power networks have shown themselves to have fundamental problems. Before discussing these management and control problems, it is important to consider some of the basic physical properties of electrical power distribution.

An AC power network is an electrical network connecting AC power generators to AC power loads on power lines controlled so that the network

as a whole can be seen to function at an essentially constant frequency and uniform phase across the network. Drifts in phase are compensated by phase shifting devices to enforce the uniform phase property across the AC power network. Drifts in frequency are compensated at the generators. Such frequency variations are typically caused by variances between the loads and generated power. The effect of these compensations is to operationally provide essentially constant frequency and uniform phase throughout the AC power network. The AC power distribution frequency in the United States, Canada, Mexico and some other countries is 60 Hz and in some other countries is 50 Hz. In certain cases, the power is distributed in a 2-phase transmission scheme. In certain other instances, the power is distributed in a 3-phase transmission scheme.

A grid as used herein will refer to an electrical power system which may comprise more than one AC power network as well as DC power lines which may transfer energy between nodes of different AC power networks or between nodes of a single AC power network.

Cities, generators and the like act as the nodes of an AC power network. A specific node may actually comprise more than one generator or load. A bus locally connects these local facilities of a node. High voltage AC transmission lines transfer power between the cities and the generators in major load centers of an AC power network. By way of example, in the United States, there's an AC power network that covers what is called the Western States Coordinating Council, which goes from British Columbia in Canada down to Northern Mexico and over to the Rocky Mountains. There's another AC power network in Texas and there's another AC power network essentially covering the rest of the United States and Canada, with the exception of a portion of Quebec. These three AC power networks are connected together by direct current lines to form the North American grid. They're not connected in AC. They are asynchronous, in that they are not synchronized either in terms of frequency or phase across the United States, Canada and northern Mexico.

Electrical power generation can be readily seen to be ephemeral and fungible. One kilowatt is reasonably treated the same as another, persisting only a relatively short period of time. Electrical power transmission can also be seen as ephemeral and fungible. Electrical power transmission is most commonly performed as AC transmission lines between nodes of an AC power network. DC power lines are used additionally to connect specific nodes of either a single AC power network or nodes of distinct AC power networks.

Electrical power storage is of typically limited time duration. The most commonly used storage system is to pump water up hill to a storage site where it is held until needed. When needed, it is gravity-fed through one or more turbines to generate electricity. Such systems, for economic reasons, are not used to store power for very long, often for no more than a day or two. It should be noted that the interface points for power into such systems are ephemeral and fungible.

Power switching between lines involving high power (megawatts and above) is not commonly done. Current examples of AC power switching include switching between amplifiers and antenna feeds in broadcast radio systems, and typically involve no more than a fraction of a megawatt. However, if such systems components someday become capable of handling large power lines, power traversing the interfaces of such switches to a power network would still be ephemeral and fungible.

There are some basic physical properties distinguishing AC power distribution systems from other flow-based systems such as DC power, gas, water and oil transmission systems. AC power networks differ from gas, water, oil and other fluid flow distribution systems in that changes in power generation and loading propagate across such networks at approximately the speed of light. The effect of power generation and power loading effects the whole AC power network in a manner that, for practical purposes, is simultaneous.

Due to the stability of frequency and phase across an AC power network, changes in power have a super positioning effect. This insures that the power

being carried on any line in the network is essentially a linear function of the generators and loads on the network. Furthermore, if a path of lines connects two nodes, generating power at the first node carried by the path is offset by power generated at the second node, as related by the above mentioned linear function.

These AC power networks are operated within a safe range, so that the patterns of flows are fairly predictable, given the configuration of the network does not change. The National Electric Reliability Council computes a system of a set of numbers called transfer distribution factors available on the North American Reliability Council website, www.nerc.com, showing how the power is distributed across these various lines. It is a linear function of the amount injected, which changes sign when the direction of transfer changes from Node1 to Node2 into Node2 to Node1. Such functions are skew symmetric with respect to the nodes.

Consider a DC network: one can directly control the delivery of power from one point to another. This cannot be done on AC power networks. It is a characteristic of AC power networks that all lines are affected in roughly fixed proportions, by the previously mentioned transfer distribution factors and by the generating and loading at specific nodes.

By way of example, when AC power is sent from Bonneville Power Authority in the state of Washington to San Francisco, some of it comes down the direct path and some of it comes down through Idaho to Arizona and back up from Southern California to Northern California. One may be limited in what can be brought from the Bonneville Power Authority to San Francisco because there's a problem with the flow coming up from Southern California to Northern California.

Consider an AC power network. It turns out that it is unlimited in how often power can be injected somewhere in that network and taken out by a load elsewhere in that network. Eventually though, the network runs out of capacity. There are certain lines or collections of lines of the network that are

going to run out ahead of others and those constrained flow elements are a big problem for the electricity industry. These lines may typically be limited either by line carrying capacity or by transformer capacity limits associated with those lines. Note that there may be more than one transformer involved and that different transformers may have differing transformer capacity limits. These constrained flow elements are called flow gates. In the last few years the importance of flow gates has begun to emerge through the actions of NERC, which has been responsible for building a model estimating flow gate impact, which can be downloaded from their web site.

A flow gate of a given AC power network will refer herein to a collection of at least one line whose total maximum safe carrying capacity will act as a congested element of the network, constraining AC power delivery between two or more nodes of that network.

All lines have maximum safe carrying capacities and thus could be considered flow gates, of a sort. However, historical congestion analysis of specific AC power networks reveals that only a small number of flow gates account for almost all congestion problems. Such flow gates will be herein referred to as significant flow gates.

The associated AC power transfer across a given flow gate is additive due to the super positioning effects previously discussed. Thus in sending 100 megawatts along a path, the transmission may have a 10% impact on the flow gate, putting 10 megawatts on the flow gate. A second generator may have a 5% impact on that flow gate. Generating 100 megawatt at the second generator would add 5 across the flow gate.

Figure 1 depicts an exemplary AC power network based upon contemporary AC power technology as found in the prior art. The network contains 12 nodes labeled **10**, **20**, **30**, **40**, **50**, **60**, **70**, **80**, **90**, **100**, **110** and **120** respectively.

AC transmission line **12** runs between node **10** and node **20**. Line **14** runs between node **10** and node **40**. Line **22** runs between node **20** and node **30**. Line **32** runs between node **30** and node **40**. Line **42** runs between node **40** and node **120**. Line **44** runs between node **40** and node **60**. Line **46** runs between node **40** and node **50**. Line **52** runs between node **50** and node **110**. Line **54** runs between node **50** and node **60**. Line **56** runs between node **50** and node **70**. Line **62** runs between node **60** and node **110**. Line **64** runs between node **60** and node **70**. Line **82** runs between node **80** and node **120**. Line **92** runs between node **90** and node **120**. Line **94** runs between node **90** and node **110**. Line **96** runs between node **90** and node **100**. Line **102** runs between node **100** and node **110**. Line **112** runs between node **110** and node **120**.

Flow gate A **210** is a constraint on the network. Lines **32**, **34** and **42** are constrained by flow gate A **210** by a total maximum safe carrying capacity, in that these lines have transmission capacity limitations which are easily overloaded when this maximum safe carrying capacity is exceeded.

Flow gate B **220** is a constraint on the network. Lines **42** and **44** are constrained by flow gate B **220**. These lines are also constrained by a total maximum safe carrying capacity due to system limitations, such as their proximity at some critical junction of the system, such as a mountain pass.

Flow gate C **230** is a constraint on the network. Lines **52** and **62** are constrained by flow gate C **230** to a total maximum safe carrying capacity.

Figure **2** depicts a list of associated AC power functions for each flow gate of a collection of flow gates for each of the busses of the various nodes of the exemplary AC power network of Figure **1** as disclosed in the prior art.

Bus **1** locally connects all facilities of Node **10**. Bus **2** locally connects all facilities of Node **20**. Bus **3** locally connects all facilities of Node **30**. Bus **4** locally connects all facilities of Node **40**. Bus **5** locally connects all facilities of Node **50**. Bus **6** locally connects all facilities of Node **60**.

Bus **7** locally connects all facilities of Node **70**. Bus **8** locally connects all facilities of Node **80**. Bus **9** locally connects all facilities of Node **90**. Bus **10** locally connects all facilities of Node **100**. Bus **11** locally connects all facilities of Node **110**. Bus **12** locally connects all facilities of Node **120**.

Note that the facilities at these nodes, connected by the associated buss, often vary greatly in terms of generation capacity as well as loading capacity. By way of example, a city often consumes far more AC power than it generates. Another example, a node for a major hydroelectric dam such as Grand Coulee Dam would tend to generate far more AC power than it consumed.

Note that the associated AC power functions for the various busses are all fractions of 1, since the most power that could be transferred is the amount of power at the generation node. Note further that some of these AC power functions are negative. Buss **10** has strictly zeroes for its power function. It is essentially acting as a reference node for calculating the associated functions.

Now consider the historical market of electrical power and electrical power transmission. For a variety of historical and technological reasons, electric power has long been a notable exception to a commodity market approach. The ability of buyers and sellers to negotiate and implement deals remains severely restricted, even where the electric power industry has been deregulated. The usual argument for these restrictions revolves around reliability.

In the United States, the Federal Energy Regulatory Commission (FERC) called for the development of Regional Transmission Organizations (RTOs) to better coordinate markets and foster reliability (Docket No. RM99-2-00 issued May 13, 1999).

The electric power industry has a long history of using centralized dispatch to manage generation, as opposed to open markets. Centralized dispatch was suited to an industry consisting of vertically integrated monopolies. The

traditional approach to RTO design so far has been to retain as much of this centralized control as possible, while opening access to competitive wholesale and retail participants. The result has been volatile prices, settlement disputes, and difficulties matching supply and demand on an instantaneous basis. The basic problem is that centralized dispatch does not work well where participants do not have common ownership or objectives.

RTO's have certain essential technical functions: providing an overall focus on reliability, regional security coordination and emergency operator intervention. RTO's have problems in the areas of scheduling, congestion management, ancillary service provisions, metering, billing and settlements. As used herein, an ancillary service often involves power generation. A power generation facility will reserve some production capacity to be available at the operators request in real-time to support balancing the network and to deal with emergency requirements which can rapidly be addressed by the reserved production capacity. Note that all the problem areas involve ephemeral, fungible electrical commodities or the economic results of transactions involving ephemeral, fungible electrical commodities.

Consider how AC power transfers are managed today. Transmission rights are considered and negotiated in terms of point-to-point transfers within the network known as contract paths. Such thinking is contrary to the previously discussed physics of these AC power networks, because changes in power generation or load at any node have an essentially linear effect on all transmission lines in the network, and consequently impact all flow gates within that network to some extent.

This contract path system of scheduling power transmission reserves transmission rights along a particular, direct path through the AC power network. This is done by purchasing transmission rights from each of the transmission line owners for each of the lines making up the direct path. It often occurs that some constraint, occurring across a significant flow gate off that direct path, actually limits the transmission capability on the direct path.

The contract path system maintains the fiction that AC power can be directed to follow a path through the network chosen as one might with natural gas. By changing the valves, one can mythically direct AC power a particular way through the AC power network. The contract path system was put in place because it was thought conceptually easier since one only had to make reservations along the single path. The fundamental problem with the contract path approach is that the contract path arrangement for transmission does not accord with the way the power actually flows in an AC power network.

Today's contract path is based upon a first-come, first-served priority scheme. What is bought has very limited resale capability. By way of example, consider three nodes A, B and C of an AC power network. Suppose one bought a power transmission from A to B and bought a transmission from B to C. Using contract path approach, that does not mean one owns the power transmission from A to C, because contract paths are not additive. Owning power transmission from A to B and from B to C would not entitle power transmission from A to C. To transport from A to C, one would have to purchase separately transmission from A to C. this is because there might be some flow gate constraint which would not be met in the two separate paths which would be triggered in the combined path. So in the contract based market, which is the traditional market, once you have purchased the transmission from A to B, it's only value is for moving energy from A to B.

Today, there are several ad hoc approaches to limiting flow on one path because of the impact on another path. These approaches ignore the physics of AC power networks. This leads to situations where even though some other path may actually be the constraint, when a particular path becomes over-constrained, cuts are issued across apparently irrelevant contracted paths to compensate. The central operator acts, because a flow gate will overflow, forbidding transmission often across apparently irrelevant paths to compensate.

Another alternative approach is to take all of these generator costs, and the preferences of the buyers, into a mathematical optimization program, and figure out the optimal flow. This alternative approach has significant disadvantages. In a commercial market, getting people to reveal all their costs is quite difficult. Most people are very reluctant to do that. Further, such costs frequently change. The loads will have to reveal their preferences between consuming and non-consuming players, which is a tremendous informational burden. It is extremely unlikely that they could or would do it. Even if they did, all this information is a tremendous burden on the central operator collecting all the information.

Such an alternative approach requires two-way communication among all the players, with all these devices and systems to control, when the people consume power and when they turn on and off these distributed devices. It has proven impossible to provide the requisite level of reliable communication and direct control systems. Besides, people are unwilling to turn over control of their business lives to a central operator.

Another approach in industry is a power pool called PJM, for Pennsylvania, New Jersey and Maryland, who have developed a system called locational pricing. It is a central dispatched methodology. However, a local flow model is buried within it. It supports some centralized management of generators, related equipment and facilties in order to get a consistent solution that is based upon the power distribution matrix.

This approach suffers from at least the same problems facing any other centralized control scheme. There is a very limited amount of detailed information such a system can acquire, or use, to optimize AC power transfers. The power users are again blind to their options. The players cannot determine what works best for them. The central operator dictates to them. It is difficult to imagine that such a situation could be optimal.

NERC has developed a methodology addressing flow gates to some extent. This is discussed in a document entitled "Discussion Paper on Aligning

Transmission Reservations and Energy Schedules to Actual Flows", distributed in November, 1998 by the NERC Transaction Reservation and Scheduling Self-Directed Work Team. This team proposed an electrical power industry shift to a system of reserving and scheduling transmission based on actual use of congested flow gates, which they called the FLOWBAT method. Their proposal suffers from a serious omission, it does not address the issue of allocating flow gate capacity when demand exceeds supply. By their silence on this issue, it appears that they would continue the current practice of first-come, first-served allocation. The flaws discussed above for centralized planning continue to be relevant in this approach.

NERC has also supported the General Agreement on Parallel Paths Experiment (GAPP). GAPP is a system whereby one transmission provider compensates a second transmission provider for the parallel power flows occurring on a second transmission provider's system caused by transactions authorized by the first transmission provider. GAPP relies on distribution functions, in this case called Transaction Participation Functions (TPFs). These distribution functions refer to transmission paths rather than flow gates. GAPP attempts to align compensation paid by transmission users with actual power flows. However, GAPP is strictly an after-the-fact settlement system. It alters the current contract path scheme only to redistribute the revenue. It does not attempt to allocate scarce transmission capacity.

To summarize, what is needed is a trading mechanism for electrical ephemeral, fungible commodities optimizing the scheduling, congestion management, ancillary services, metering, billing and settlements of accounts for electrical grids. Further, what is needed is an AC power transmission market system complying with the physics of AC power networks. Further, since transmission rights are predominantly constrained by significant flow gates, what is needed should account for the effect on the significant flow gates for each contracted transmission. A method and mechanism is needed for trading generation and transmission rights in a timely, reliable and efficient manner which automatically guarantees correct operation of the power grid.

Summary of the invention

Certain embodiments fulfill at least the requirements and needs discussed with regards to the prior art.

Certain embodiments include a method and apparatus for trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network each containing a node collection of at least two nodes. The method includes maintaining a market interval collection of market intervals and maintaining a validated order collection of validated orders, each with an associated market interval. Each market interval contains a product type, location and at least one time interval. Each market interval advantageously defines a market for a specific product type at a given location, which exists during essentially the time interval of the market interval, an ephemeral, fungible commodity.

Each validated order has an associated market interval and is a member of a collection including an ask validated order and a bid validated order. The associated market state of each market interval of the market interval collection comprises a market price for the market interval product type at the market interval location during the market interval time interval.

The product type of a market interval includes energy and AC power transfer. The location of a market interval with an energy product type is a node of an AC power network node collection. The location of a market interval with an AC power transfer product type is from a first node of a first AC power network node collection to a second node of the first AC power network node collection.

Certain further embodiments include validated orders comprising multiple validated orders, each with associated market intervals, where the associated market intervals may differ in location, or differ in product type. Such embodiments allow for complex orders to be processed, so that energy may be ordered along with the transmission rights for that power.

Certain further embodiments include an AC power network in the electrical power grid further containing a flow gate collection. For each flow gate of the flow gate collection, there is at least one market interval with AC power transfer product type and location of the flow gate. Such embodiments advantageously provide a trading mechanism for AC power transfers across flow gates, which is in keeping with the physical characteristics of AC power networks. Note that again, each of these market intervals are markets for ephemeral, fungible commodities, AC power transfer effects across a flow gate during a time interval.

Certain other further embodiments includes electrical power grids further containing a DC power line collection of at least one DC power line from a first node of a first AC power network to a second node of a second AC power network. The product type collection further includes DC power transfers. Market intervals with DC power transfer product types have locations the same as the DC power line. Such embodiments advantageously provide market for additional ephemeral, fungible commodities, DC power transfers over specific DC power lines during specific time intervals.

Certain embodiments include where each market interval further contains a window time interval during which the market interval is active only within the window time interval. The window time interval of the market interval occurs before the time interval contained in the market interval of each of the market intervals of the market interval collection. Such embodiments advantageously provide for trading in the ephemeral, fungible commodity of the market interval before the products exist. This insures that trading is completed before scheduling the generation and transmission resources of the electrical power grid.

Certain further embodiments include a market interval containing multiple time intervals as well as the window time interval. The multiple time intervals of the market interval do not overlap each other. The window time interval of the market interval occurs before each of the time intervals contained in the

market interval of each of the market intervals of the market interval collection. Such embodiments advantageously provide for trading in a collection of time intervals such as the peak usage hours of a day.

Certain other further embodiments further include an operation establishing a real time. A real time is a reference to time by which ephemeral, fungible commodities may exist. Maintaining the validated order collection further includes determining which validated orders are no longer in their window time interval based upon the real time, and removing those validated orders where the real time is no longer contained in the window time interval. Such embodiments advantageously provide for removing trading in market intervals which pass outside their window time interval.

Certain embodiments include contracting to create an agreed contract from the validated order collection. Contracting to create an agreed contract from the validated order collection further includes determining a first bid validated order with a first ask validated order for a first market interval in terms of price to create an agreed price; calculating an agreed amount; creating the agreed contract for the first market interval at the agreed price for the agreed amount with first bid validated order and first ask validated order. Such embodiments advantageously support forming contracts based upon the validated orders of the virtual trading floor for the ephemeral, fungible commodities of the electrical power grid.

Certain further embodiments include maintaining the validated order collection further including removing at least one of the first bid validated order and the first ask validated order from the validated order collection. Such embodiments advantageously support removing bids and asks which are no longer active, since they have become bound by the agreed contract.

Certain further embodiments include removing the first bid validated order from a validated order containing multiple validated orders including the first bid validated order. Such an embodiment advantageously supports removing a first bid validated order from a validated order containing multiple validated

order including the first bid validated order. Certain other further embodiments include removing the first ask validated order from a validated order containing multiple validated orders including the first ask validated order. Such an embodiment advantageously supports removing a first ask validated order from a validated order containing multiple validated order including the first ask validated order.

Certain further embodiments include maintaining a certified client collection of certified clients. Each of the validated orders of the validated order collection contains an ordering client of the certified client collection. Maintaining the validated order collection further comprises receiving an order message from a first certified client, processing the received order message from the first certified client and inserting the processed, received order message into the validated order collection as a validated order with the ordering client as the first certified client. Such embodiments advantageously provide for the reception, processing and insertion of validated orders in the validated order collection from order messages received from certified clients.

Certain further embodiments advantageously include extension of contracting to create an agreed contract from the validated order collection to include sending the ordering clients of the first bid validated order and the first ask validated order notice of the agreed contract.

Certain embodiments advantageously include extension of maintaining the market collection of market intervals to include calculating the associated market price of each of the market intervals of the market collection based upon the bid validated orders for the market interval and the ask validated orders of the market interval. Such embodiments advantageously support calculating of the current market price of active market intervals based upon the bid and ask orders for that market interval.

In certain further embodiments, a market interval of the market interval collection may further contain a capacity option type. Validated orders with the associated first market interval containing a capacity option type further

comprise a capacity option price. Determining the first bid validated order for the first market interval agreeing with the first ask validated order with said associated first market interval in terms of price to create the agreed price includes determination also in terms of capacity option price. Calculating an agreed amount in terms of price further includes calculating in terms of capacity option price. Creating the agreed contract for the market interval at the agreed price for the agreed amount includes the agreed capacity option price. Such embodiments advantageously provide for capacity option contracting of ephemeral, fungible commodities in the electrical power grid.

In certain further embodiments, for each market interval containing a capacity option type, the associated market state further contains an associated capacity option market price. Maintaining the market interval collection further comprises calculating the associated capacity option market price of each market interval containing a capacity option type based upon the bid orders and ask orders for the market interval. Such embodiments advantageously support calculating of the current market capacity option price of active capacity option market intervals based upon the bid and ask orders for that market interval.

Certain embodiments advantageously support the operations discussed herein as program code segments included in a program operating system executed by a computing system including at least one computer with coupled computer readable memory. The program code segments are not required to all belong to the same instruction execution family, they may advantageously include program code segments executing on multiple computers. The computing system may advantageously further include a client computer collection and a server system coupled by a network. The network may advantageously couple with specific client computers continuously or sporadically. The server system includes at least one server computer with accessibly coupled computer memory. In certain further embodiments, the server system advantageously includes multiple server computers coupled to the network, each with coupled accessible computer memory. In certain

further embodiments, the server system supports redundant program code segments maintaining various parts or all of the virtual trading floor for the ephemeral, fungible commodities.

Certain embodiments include a method and apparatus for trading ephemeral, fungible commodities. The method includes maintaining a market interval collection of market intervals and maintaining a validated order collection of validated orders, each with an associated market interval. Each market interval contains a product type, location and at least one time interval. Each market interval advantageously defines a market for a specific product type at a given location, which exists during essentially the time interval of the market interval, an ephemeral, fungible commodity.

Each validated order has an associated market interval and is a member of a collection including an ask validated order and a bid validated order. The associated market state of each market interval of the market interval collection comprises a market price for the market interval product type at the market interval location during the market interval time interval.

Certain embodiments advantageously support the operations discussed herein as program code segments included in a program operating system executed by a computing system including at least one computer with coupled computer readable memory.

These and other advantages of the present invention will become apparent upon reading the following detailed descriptions and studying the various figures of the drawings.

Brief Description of the Drawings

Figure **1** depicts an exemplary AC power network based upon contemporary AC power technology as found in the prior art;

Figure **2** depicts a list of associated AC power functions for each flow gate of a collection of flow gates for each of the busses of the various nodes of the exemplary AC power network of Figure **1** as disclosed in the prior art;

Figure **3A** depicts a virtual trading floor **1000**, containing validated orders and market intervals with associated market states in accordance with certain embodiments;

Figure **3B** depicts a market interval containing a product type, location and time interval in accordance with certain embodiments;

Figure **3C** depicts a refinement of a market interval as depicted in Figure **3B** further containing multiple time intervals in accordance with certain embodiments;

Figure **4** depict a flowchart of operations for a method of a virtual trading floor trading ephemeral, fungible commodities in accordance with certain embodiments;

Figure **5A** depicts a validated order **1200** of the validated order collection in accordance with certain embodiments;

Figure **5B** depicts a refinement of Figure **5a** of a validated order **1200** of the validated order collection in accordance with certain further embodiments;

Figure **6A** depicts a refinement of Figure **3B** of a market interval of an energy product type in accordance with certain embodiments;

Figure **6B** depicts a refinement of Figure **3B** of a market interval of an AC power transfer product type in accordance with certain embodiments;

Figure **7** depicts a validated order **1200** comprised of at least two validated orders, each with an associated market interval in accordance with certain embodiments;

Figure **8A** depicts a market interval of a DC power line in accordance with certain embodiments;

Figure **8B** depicts market interval **1200** of Figure **3B** further containing a window time interval during which said market interval is active only within said window time interval in accordance with certain embodiments;

Figure **8C** depicts market interval **1200** of Figure **8B** containing a window time interval and multiple time intervals in accordance with certain embodiments;

Figure **9A** depicts a detail flowchart of operation **2000** of Figure **4** performing establishing a real time;

Figure **9B** depicts a detail flowchart of operation **2022** of Figure **4** performing determining whether to remove a validated order from the validated order collection when its associated market interval's window has passed;

Figure **10A** depicts a detail flowchart of operation **2000** of Figure **4** performing contracting to create an agreed contract from said validated order collection;

Figure **10B** depicts a detail flowchart of operation **2092** of Figure **10A** performing contracting to create an agreed contract from said validated order collection;

Figure **11A** depicts a detail flowchart of operation **2022** of Figure **4** performing removing first bid and first ask validated orders from the validated order collection;

Figure **11B** depicts a detail flowchart of operation **2142** of Figure **11A** performing removing the first bid validated order from the multiple validated order, in accordance with embodiments where the first bid validated order is originally contained in a multiple validated order containing a second validated order;

Figure **11C** depicts a detail flowchart of operation **2152** of Figure **11A** performing removing the first ask validated order from a multiple validated order, in accordance with embodiments where the first ask validated order is originally contained in a multiple validated order containing a second validated order;

Figure **12A** depicts a detail flowchart of operation **2000** of Figure **4** performing maintaining a certified client collection of certified clients;

Figure **12B** depicts a detail flowchart of operation **2022** of Figure **4** performing receiving an order message from a certified client, processing and inserting it into the validated order collection, in accordance with certain embodiments where each of said validated orders of said validated order collection contains an ordering client;

Figure **13** depicts a refinement of the virtual trading floor **1000** as depicted in Figure **3A**, containing validated orders and market intervals with associated market states and further containing certified clients in accordance with certain embodiments;

Figure **14** depicts a simplified system block of a computing system **3000** supporting interaction between a collection of certified clients and a computing system based upon interactions involving a virtual trading floor in accordance with certain embodiments;

Figure **15** depicts a refinement of computing system **3000** as a system diagram in Figure **14** in accordance with certain further embodiments; This computing system is comprised of a client computer collection and a server system **3500** coupled to a network **3200**;

Figure **16** depicts a detail flowchart of operation **2092** of Figure **10A** performing notified biding and asking clients of the agreed contract for their respective validated orders;

Figure **17A** depicts a detail flowchart of operation **2004** of Figure **4** performing calculating the market price of each market interval in the market interval collection;

Figure **17B** depicts a refinement of Figure **3B** of a market interval **1100** further containing a capacity option type **1118**;

Figure **17C** depicts a refinement of the validated order of Figure **5B** further containing **1340** a capacity option price **1342**;

Figure **18A** depicts a detail flowchart of operation **2112** of Figure **10B** performing determining bid order agreement with ask order for an associated capacity option market interval;

Figure **18B** depicts a detail flowchart of operation **2116** of Figure **10B** performing calculating an agreed option amount;

Figure **18C** depicts a detail flowchart of operation **2120** of Figure **10B** performing creating the agreed contract at the agreed price and the agreed option price for the agreed amount whenever the first bid order agrees with the first ask order in terms of the price and the option price;

Figure **19A** depicts a market state **1102** associated with a market interval **1100** as show in Figures **3A**, **13** and **17B** in accordance with certain embodiments;

Figure **19B** depicts a detail flowchart of operation **2004** of Figure **17A** performing calculating the capacity option price **1102-2** for the market state **1102** as shown in Figure **19A** of a market interval as shown in Figure **17B** containing a capacity option **1118**;

Figure **20** depicts a method of controlling the interaction between a client **1400** and a virtual trading floor comprising maintaining a session component **3300**, participant component **3320** and market segment **3340** in accordance with certain embodiments;

Figure **21** depicts a refinement of computing system **3000** as a system diagram in Figure **15** in accordance with certain further embodiments;

Figure **22** depicts a view of a certified client user interface operating on a client computer showing an ordering screen with hourly time interval based market intervals for a specific energy market in accordance with certain embodiments;

Figure **23** depicts a view of a certified client user interface operating on a client computer showing an ordering screen for daily on-peak time interval based market intervals for a specific energy market in accordance with certain embodiments; and

Figure **24** depicts a view of a certified client user interface operating on a client computer showing an ordering screen for hourly time interval based market intervals for a specific flow gate market in accordance with certain embodiments.

Detailed Description of the Invention

Figure **3A** depicts a virtual trading floor **1000**, containing validated orders and market intervals with associated market states in accordance with certain embodiments.

A virtual trading floor mechanism **1000** comprises a collection of market intervals, each with an associated market state, and validated orders. A market contains a product type and a location. Trading in the market is done in terms of market intervals **1100**, **1120**, **1140** and **1160**. Each market interval of a market contains the market product type, market location, plus a calendar scheme with an interval end. The market state of a market interval comprises a market price for the market interval product type at the market interval location during the market interval time interval.

In certain further embodiments, a validated order contains an amount of the market interval product type, a price for the market interval product type. The validated order is either a bid order or an ask validated order.

In certain further embodiments, a virtual trading floor supports trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network. Each AC power network further contains a node collection of at least two nodes. In certain further embodiments, the product type of the market intervals of the market interval collection is a member of a product type collection comprised of energy and AC power transfer. In certain

further embodiments, the location of a market interval having an energy product type is a first node of the node collection of an AC power network contained in the electrical power grid. In certain further embodiments, the location of a market interval having an AC power transfer product type is from a first node of a first AC power network contained in the electrical power grid to a second node of the first AC power network.

Figure **3B** depicts a market interval containing a product type, location and time interval in accordance with certain embodiments. The product types include ephemeral, fungible commodities in certain embodiments. In certain further embodiments, all product types are ephemeral, fungible commodities.

In certain embodiments, location refers to a single node. In certain embodiments, a node may be specified geographically. In certain embodiments, a node may be specified in terms of nodes in a network, containing both a collection of nodes and a collection of lines, each line from a first node to a second node. Note that the term line as used herein does not exclusively imply a straight line. In certain embodiments, a node may be specified in terms of a node of a network contained in a grid of one or more network, which may further contain special lines connecting nodes of potentially distinct networks.

In certain further embodiments, location may additionally refer to a transition or transfer from a first node to a second node. As discussed above, such a transition in a network would correspond to a line between the first node and the second node.

Figure **3C** depicts a refinement of a market interval as depicted in Figure **3B** further containing multiple time intervals in accordance with certain embodiments. In this figure, two time intervals are depicted by way of example. In certain embodiments, more than two time intervals may be contained in one market interval. In certain further embodiments, each of the multiple time intervals does not temporally overlap the other contained time intervals of the market interval.

Figure **4** depict a flowchart of operations for a method of a virtual trading floor trading ephemeral, fungible commodities in accordance with certain embodiments.

Operation **2000** starts the operations of this flowchart. Arrow **2002** directs the flow of execution from operation **2000** to operation **2004**. Operation **2004** performs maintaining a market interval collection of market intervals. Arrow **2006** directs execution from operation **2004** to operation **2008**. Operation **2008** terminates the operations of this flowchart.

Arrow **2020** directs the flow of execution from starting operation **2000** to operation **2022**. Operation **2022** performs maintaining a validated order collection of validated orders. Arrow **2024** directs execution from operation **2022** to operation **2008**. Operation **2008** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting the virtual trading floor for ephemeral, fungible commodities.

As used herein, the term computer refers to devices including instruction set computers, inferential computers, and analog computers, as well as aggregates of these basic kinds of computers. A computer will also refer to informational appliances incorporating one or more computers in their construction. Such informational appliances may be physically distinct units, or they may be tangibly integrated into other devices, or they may be tangibly integrated into the physically mobile neighborhood of one or more human beings.

As used herein, certain computers, including instruction-processing computers and inferential computers include coupled computer readable memory to hold what will be termed herein as instructions. Instructions as used herein with regard to instruction set computers will refer to information

controlling state transition of such instruction computers. Based upon the current individual or collection of instructions being executed, and its internal state, the instruction-processing computer will determine the future state of the instruction-processing computer. Note that these instructions may either be directly executed by the instruction-processing computer or may be interpretively executed by the instruction-processing computer.

Instructions as used herein with regard to inferential computers will refer to information presented to the inferential computer used to infer the future state of the computer based upon an inference base of the inferential computer directed by the presented instruction. Such an inference base may reside internal to the inferential computer in certain cases, or reside in coupled computer accessible memory, which may be both read and written by the inferential computer. Note that inferential computers include but are not limited to machines executing various forms of Horn clause predicates as well as constraint rules, pattern recognition templates, fractal pattern templates and fuzzy logic predicate structural elements.

Analog computers as used herein include, but are not limited to, devices directly coupling to analog circuitry. Such analog circuitry as used herein includes, but is not limited to, radio frequency IF stages, opto-electronic interfaces such as lasers embedded in fiber optic communications systems, audio and video pattern recognition circuitry, audio and video output devices. Analog computers as used herein include but are not limited to acoustic interfaces to humans, audio and visual identification portals to the contracting of AC power transfer regarding flow gates, encoding and decoding mechanisms used in long distance communication and interfaces to recording devices of agreed contracts.

A program code segment as used herein refers to instructions in a form executable or inferentially directing for the computer coupled to the computer readable memory in which the program code segment resides. Note that in certain embodiments, program code segments may be native executable

instructions of an instruction-processing computer. In certain other embodiments, program code segments may be interpretively executed instructions of an instruction-processing computer.

Figure **5A** depicts a validated order **1200** of the validated order collection in accordance with certain embodiments.

Validated order **1200** has an associated **1300** market interval **1100-N** of the market interval collection. The market interval collection is separately maintained in certain embodiments. In certain embodiments, maintaining the validated order collection and market interval collections are coupled.

Each validated order **1200** further contains a member of the order type collection **1310** which is either a bid order **1312** of the associated **1300** market interval **1100-N** or an ask validated order **1314** of the associated **1300** market interval **1100-N**.

Figure **5B** depicts a refinement of Figure **5A** of a validated order **1200** of the validated order collection in accordance with certain further embodiments.

As depicted in Figure **5A**, validated order **1200** has an associated **1300** market interval **1100-N** of the market interval collection. The market interval collection is separately maintained in certain embodiments. In certain embodiments, maintaining the validated order collection and market interval collections are coupled.

As depicted in Figure **5A**, each validated order **1200** further contains a member of the order type collection **1310** which is either a bid order **1312** of the associated **1300** market interval **1100-N** or an ask validated order **1314** of the associated **1300** market interval **1100-N**.

In certain further embodiments, a validated order may contain **1320** an amount **1322** of the product type **1110-N** of the associated **1300** market interval **1100-N**.

In certain further embodiments, a validated order may contain **1330** a price **1332** of the product type **1110-N** of the associated **1300** market interval **1100-N**.

Figure **6A** depicts a refinement of Figure **3B** of a market interval of an energy product type in accordance with certain embodiments. The product type **1110** of the market interval is further described as an energy product type **1110**. The location **1112** is a first node of an AC power network contained in the electrical power grid.

Figure **6B** depicts a refinement of Figure **3B** of a market interval of an AC power transfer product type in accordance with certain embodiments. The product type **1110** of the market interval is further described as an Energy product type **1110**. The location **1112** is from a first node of a first AC power network contained in the electrical power grid to a second node of the first AC power network. Note that this form of location is a line between the first node of the first AC power network and a second node of the first AC power network.

Figure **6C** depicts a refinement of Figure **6B** of a market interval of an AC power transfer product type in accordance with certain embodiments. The product type **1110** of the market interval is described as an Energy product type **1110**. The location **1112** is a flow gate of the flow gate collection of a first AC power network contained in the electrical power grid. Note that flow gates can represent a congestion constraint across more than one transmission line, and may not have a specific first node to second node description.

Figure **7** depicts a validated order **1200** comprised of at least two validated orders, each with an associated market interval in accordance with certain embodiments.

Validated order **1200-1** has an associated **1300-1** market interval **1100-N-1** of the market interval collection. Validated order **1200-1** further contains a

member of the order type collection **1310-1** which is either a bid order **1312** of the associated **1300** market interval **1100-N-1** or an ask validated order **1314** of the associated **1300** market interval **1100-N-1**.

Validated order **1200-2** has an associated **1300-2** market interval **1100-N-2** of the market interval collection. Validated order **1200-2** further contains a member of the order type collection **1310-2** which is either a bid order **1312** of the associated **1300** market interval **1100-N-2** or an ask validated order **1314** of the associated **1300** market interval **1100-N-2**.

Validated order **1200-3** has an associated **1300-3** market interval **1100-N-3** of the market interval collection. Validated order **1200-3** further contains a member of the order type collection **1310-3** which is either a bid order **1312** of the associated **1300** market interval **1100-N-3** or an ask validated order **1314** of the associated **1300** market interval **1100-N-3**.

In certain further embodiments, there is no specific limit to the number of validated orders comprising a validated order. In certain other further embodiments, there is a limit to the number of validated orders comprising a validated order.

In certain embodiments, the associated market intervals of multiple validated orders within a validated order share the same product type. In certain embodiments, the associated market intervals of multiple validated orders within a validated order may share the same location.

In certain embodiments, the associated market intervals of multiple validated orders within a validated order differ in product type. In certain embodiments, the associated market intervals of multiple validated orders within a validated order differ in location.

As discussed in the background, the physic of AC power networks indicates each AC power network contained in the electrical power grid further contains a flow gate collection of flow gates. Each flow gate location being either from an associated first node of the AC power network to an associated second

node of the AC power network, or in the case of a collection of constrained transmission lines, will be denoted by a flow gate designator. An AC power transfer amount from node1 to node2 produces an amount of AC power transfer across the flow gate as essentially an associated linear, skew-symmetric function of the amount from node1 to node2, for each of the flow gates of the flow gate collection. For each of the flow gates of the flow gate collection, there is at least one market interval in the market interval collection of AC power transfer product type with the flow gate location.

In certain embodiments, each validated order of the validated order collection with the AC power transfer product type of the associated market interval further contains an amount. In certain further embodiments, a validated order of AC power transfer product type from the first node to the second node is further comprised of a validated order of the flow gate associated market interval. The amount ordered for that flow gate is essentially the associated linear, skew-symmetric function of the amount from the first node to the second node, for each of the flow gates of the flow gate collection.

Note that in certain further embodiments, there is a price associated with each validated order of the AC power transfers of the flow gates. In certain further embodiments, there is a price associated with the AC power transfer from the first node to the second node.

Figure **8A** depicts a market interval of a DC power line in accordance with certain embodiments. In certain embodiments, an electrical power grid further contains a DC power line collection of at least one DC power line at the location of the DC power line from a first node of a first AC power network to a second node of a second AC power network. The product type collection further comprises DC power transfer. For each DC power line of the DC power line collection, there is at least one associated market interval with DC power transfer product type, with the location as the location of the DC power line.

Figure **8B** depicts market interval **1200** of Figure **3B** further containing a window time interval during which the market interval is active only within the window time interval in accordance with certain embodiments. The window time interval of the market interval entirely occurs before the time interval contained in the market interval for each market interval.

Figure **8C** depicts market interval **1200** of Figure **8B** containing a window time interval and multiple time intervals in accordance with certain embodiments. Each of the time intervals does not overlap the other time intervals. The window time interval occurs before each of the time intervals.

Figure **9A** depicts a detail flowchart of operation **2000** of Figure **4** performing establishing a real time. A real time is a temporal reference used to determine whether the window time interval contains the real time, making validated orders with the associated market interval active.

Arrow **2040** directs the flow of execution from starting operation **2000** to operation **2042**. Operation **2042** performs establishing a real time. Arrow **2044** directs execution from operation **2042** to operation **2046**. Operation **2046** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **9B** depicts a detail flowchart of operation **2022** of Figure **4** performing determining whether to remove a validated order from the validated order collection when its associated market interval's window has passed.

Arrow **2060** directs the flow of execution from starting operation **2022** to operation **2062**. Operation **2062** performs determining whether the real time is contained in the window time interval for the market interval of the validated order of the validated order collection. Arrow **2064** directs execution from operation **2062** to operation **2066**. Operation **2066** performs removing the

validated order from the validated order collection whenever the real time is not contained in the window time interval for the associated market interval of the validated order. Arrow **2068** directs execution from operation **2066** to operation **2070**. Operation **2070** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **10A** depicts a detail flowchart of operation **2000** of Figure **4** performing contracting to create an agreed contract from the validated order collection.

Arrow **2090** directs the flow of execution from starting operation **2000** to operation **2092**. Operation **2092** performs contracting to create an agreed contract from the validated order collection. Arrow **2094** directs execution from operation **2092** to operation **2096**. Operation **2096** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **10B** depicts a detail flowchart of operation **2092** of Figure **10A** performing contracting to create an agreed contract from the validated order collection.

Arrow **2110** directs the flow of execution from starting operation **2092** to operation **2112**. Operation **2112** performs determining a first bid order for a first market interval agreeing with a first ask validated order for the first market interval in terms of price to create an agreed price. Arrow **2114** directs execution from operation **2112** to operation **2116**. Operation **2116** performs calculating an agreed amount for the market interval at the agreed price based upon the first bid order and first ask validated order. Arrow **2118**

directs execution from operation **2116** to operation **2120**. Operation **2120** performs creating the agreed contract for the market interval at the agreed price for the agreed amount whenever the first bid order agrees with the first ask validated order in terms of the price. Arrow **2122** directs execution from operation **2120** to operation **2124**. Operation **2124** terminates the operations of this flowchart.

In certain embodiments, not all validated orders have a price associated with them. Consider an AC power transfer from node1 to node2 of an AC power network. Assume that AC power network has a collection of three flow gates. A validated order for an AC power transfer amount from node1 to node2 may contain validated orders for an associated amount for each flow gate of the flow gate collection. Each of the flow gate validated orders may contain prices for their respective flow gate. The agreed amount would be calculated based upon the associated amounts and pricing of the flow gates. In certain other embodiments, all validated orders have a price associated with them.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **11A** depicts a detail flowchart of operation **2022** of Figure **4** performing removing first bid and first ask validated orders from the validated order collection.

Arrow **2140** directs the flow of execution from starting operation **2022** to operation **2142**. Operation **2142** performs removing the first bid validated order from the validated order collection. Arrow **2144** directs execution from operation **2142** to operation **2146**. Operation **2146** terminates the operations of this flowchart.

Arrow **2150** directs the flow of execution from starting operation **2022** to operation **2152**. Operation **2152** performs removing the first ask validated

order from the validated order collection. Arrow **2154** directs execution from operation **2152** to operation **2146**. Operation **2146** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **11B** depicts a detail flowchart of operation **2142** of Figure **11A** performing removing the first bid validated order from the multiple validated order, in accordance with embodiments where the first bid validated order is originally contained in a multiple validated order containing a second validated order.

Arrow **2170** directs the flow of execution from starting operation **2142** to operation **2172**. Operation **2172** performs removing the first bid validated order from the validated order collection comprises removing the first bid validated order from the validated order. Arrow **2174** directs execution from operation **2172** to operation **2176**. Operation **2176** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **11C** depicts a detail flowchart of operation **2152** of Figure **11A** performing removing the first ask validated order from a multiple validated order, in accordance with embodiments where the first ask validated order is originally contained in a multiple validated order containing a second validated order.

Arrow **2190** directs the flow of execution from starting operation **2152** to operation **2192**. Operation **2192** performs removing the first ask validated

order from the validated order. Arrow **2194** directs execution from operation **2192** to operation **2196**. Operation **2196** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **12A** depicts a detail flowchart of operation **2000** of Figure **4** performing maintaining a certified client collection of certified clients.

Arrow **2210** directs the flow of execution from starting operation **2000** to operation **2212**. Operation **2212** performs maintaining a certified client collection of certified clients. Arrow **2214** directs execution from operation **2212** to operation **2216**. Operation **2216** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **12B** depicts a detail flowchart of operation **2022** of Figure **4** performing receiving an order message from a certified client, processing and inserting it into the validated order collection, in accordance with certain embodiments where each of the validated orders of the validated order collection contains an ordering client.

Arrow **2230** directs the flow of execution from starting operation **2022** to operation **2232**. Operation **2232** performs receiving an order message from a first of the certified clients of the certified client collection to create a received order message from the first certified client. Arrow **2234** directs execution from operation **2232** to operation **2236**. Operation **2236** performs processing the received order message from the first certified client to create a first

processed order from the first certified client. Arrow **2238** directs execution from operation **2236** to operation **2240**. Operation **2240** performs inserting the first processed order from the first certified client into the validated order collection to create a validated order containing the first certified client as the order client contained in the validated order collection. Arrow **2242** directs execution from operation **2240** to operation **2244**. Operation **2244** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **13** depicts a refinement of the virtual trading floor **1000** as depicted in Figure **3A**, containing validated orders and market intervals with associated market states and further containing a certified client collection of certified clients in accordance with certain embodiments.

As depicted in Figure **3A**, virtual trading floor mechanism **1000** comprises a collection of market intervals, each with an associated market state, and validated orders. A market contains a product type and a location. Trading in the market is done in terms of market intervals **1100**, **1120**, **1140** and **1160**. Each market interval of a market contains the market product type, market location, plus a calendar scheme with an interval end. The market state of a market interval comprises a market price for the market interval product type at the market interval location during the market interval time interval.

As depicted in Figure **3A**, in certain further embodiments, a validated order contains an amount of the market interval product type, a price for the market interval product type. The validated order is either a bid validated order or an ask validated order.

This figure also depicts a certified client collection comprised of certified clients. In certain embodiments certified clients include but are not limited to

human beings. In certain further embodiments, certified clients further include but are not limited to corporate entities. In certain further embodiments, certified clients further include agents authorized by the certified clients to represent them in interactions regarding the virtual trading floor. In certain further embodiments, certified clients further include software agents executing on software agent computers authorized by certified clients to represent them in interactions regarding the virtual trading floor.

As depicted in Figure **3A**, in certain further embodiments, a virtual trading floor supports trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network. Each AC power network further contains a node collection of at least two nodes. In certain further embodiments, the product type of the market intervals of the market interval collection is a member of a product type collection comprised of energy and AC power transfer. In certain further embodiments, the location of a market interval having an energy product type is a first node of the node collection of an AC power network contained in the electrical power grid. In certain further embodiments, the location of a market interval having an AC power transfer product type is from a first node of a first AC power network contained in the electrical power grid to a second node of the first AC power network.

Figure **14** depicts a simplified system block of a computing system **3000** supporting interaction between a collection of certified clients and a computing system based upon interactions involving a virtual trading floor in accordance with certain embodiments.

Computing system **3000** is comprised of at least one computer **3020** coupled **3024** to computer readable memory **3026**. The communication and interaction between computing system **3000** and computer **3020** is denoted by arrow **3022**. Such communication and interaction **3022** may employ a variety of communications technologies, including a wireless physical transport layer in certain embodiments. In certain alternative embodiments,

communication and interaction **3022** may employ a wireline physical transport layer.

Note that in certain embodiments, these entities, the human being **3100**, corporate entity **3120**, agent **3140** and software agent **3160** communicate with computing system **3000** by use of messages as represented by arrows **3102**, **3122**, **3142**, and **3182**, respectively. In certain embodiments, such messages may use a wireline physical transport layer as represented by one or more of the arrows **3102**, **3122**, **3142**, and **3182**. In certain embodiments, such messages may use a wireless physical transport layer as represented by one or more of the arrows **3102**, **3122**, **3142**, and **3182**. Such messages may use body signals in certain further embodiments. Such messages may further use hand signals. Such message in other embodiments may use acoustic signaling of messages. Such messages in certain further embodiments may use verbal messages in a human language.

Figure **15** depicts a refinement of computing system **3000** as a system diagram in Figure **14** in accordance with certain further embodiments. This computing system is comprised of a client computer collection and a server system **3500** coupled to a network **3200**.

The client computer collection is comprised of at least one client computer **3600** operated **3192** by certified client **1400**. In certain further embodiments, client computer **2610** operated **3104** by a human being as client **3100**. In certain other further embodiments, client computer **2620** operated **3124** by a corporate entity as client **3120**. In certain other further embodiments, client computer **2630** operated **3144** by an authorized agent as client **3140**. The certified client is represented by an agent authorized by the first party to act on behalf of the first party with respect to contracting the AC power transfer.

Server system **3500** includes at least one server computer **3520** coupled to network **3200**. Network **3200** further couples **3602**, **3612**, **3622**, **3632** and **3642** to client computers **3600**, **3610**, **3620**, **3630** and **3640**, respectively. Network **3200** at least supports communication between client computers and

at least one server computer **3520** of server system **3500**. As used herein, the term network refers not only to Local Area Networks (LANs), but also to Wide Area Networks (WANs). Network supported communication as used herein includes, but is not limited to, digital communication protocols as well as analog communication protocols. Network supported communication as used herein further includes, but is not limited to, message passing protocols and packet based protocols. Network supported communication as used herein further includes, but is not limited to, communication protocols including TCP/IP. Network supported communication as used herein further includes, but is not limited to, communication protocols supporting the Internet. Network supported communication as used herein further includes, but is not limited to, communication protocols supporting the World Wide Web.

In certain further embodiments, client computer **3610** with coupled **3614** computer readable memory **3616** operated **3104** by a client **1400** further coupled **3194** to computer readable memory **3606**. In certain further embodiments, client computer **3640** with coupled **3644** computer readable memory **3646** operated **3164** by a software agent as client **3160**. In certain other further embodiments, the coupling **3194** provides various personal optimizations and shortcuts, including but not limited to macro style functions and standard contract forms employed by the client **1400**.

In certain other further embodiments, server system **3500** includes at least one server computer **3520** coupled **3524** to computer readable memory **3526**.

Figure **16** depicts a detail flowchart of operation **2092** of Figure **10A** performing notified biding and asking clients of the agreed contract for their respective validated orders.

Arrow **2270** directs the flow of execution from starting operation **2092** to operation **2272**. Operation **2272** performs extracting from the first bid validated order to create a bid certified client. Arrow **2274** directs execution from operation **2272** to operation **2276**. Operation **2276** performs extracting

from the ask validated order to create an ask certified client. Arrow **2278** directs execution from operation **2276** to operation **2280**. Operation **2280** performs sending a bid contract message based upon the agreed contract to the bid client. Arrow **2282** directs execution from operation **2280** to operation **2284**. Operation **2284** performs sending an ask contract message based upon the agreed contract to the ask client. Arrow **2286** directs execution from operation **2284** to operation **2288**. Operation **2288** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **17A** depicts a detail flowchart of operation **2004** of Figure **4** performing calculating the market price of each market interval in the market interval collection.

Arrow **2310** directs the flow of execution from starting operation **2004** to operation **2312**. Operation **2312** performs calculating the associated market price of each of the market intervals of the market interval collection based upon the bid validated orders of the validated order collection for the market interval and the ask validated orders of the validated order collection for the market interval. Arrow **2314** directs execution from operation **2312** to operation **2316**. Operation **2316** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **17B** depicts a refinement of Figure **3B** of a market interval **1100** further containing a capacity option type **1118**. In certain embodiments, capacity options are found as ancillary services in AC power networks providing

network operators real-time resources to maintain AC power network operational parameters within regulatory and safety limits. In certain other embodiments, capacity options may be used by certified clients to provide for rapidly applied increases from production facilities of ephemeral, fungible commodities being traded on the virtual trading floor.

Figure **17C** depicts a refinement of the validated order of Figure **5B** further containing **1340** a capacity option price **1342**. In certain embodiments, capacity options are traded to permit reservation of an ephemeral, fungible commodity amount. Such reservations have a price, the capacity option price, besides just price of purchase. In agreeing to a capacity option contract, the seller is only guaranteed the earnings of the capacity option price, and the buyer acquires the right to buy the amount of capacity at or close to real time (subject to scheduling constraints). If the buyer elects to buy the optioned capacity, it is at the price already agreed upon in the contract. The seller then makes additional income from the actual purchased amount at the agreed price.

In certain embodiments, the virtual trading floor applies to a power grid containing at least one AC power network, and capacity options can exist for a variety of generation options, including what is sometimes known as spinning and non-spinning resources. Spinning resources are often turbine generators rotating already at operational speed, and thus can be brought on line in a short time. Non-spinning resources include turbines, which are either still, or far below operational rates. Such turbines often take 15-30 minutes to come up to operational speed. These operational distinctions are part of the scheduling constraints that guide the use of such capacity option activities.

Figure **18A** depicts a detail flowchart of operation **2112** of Figure **10B** performing determining bid order agreement with ask order for an associated capacity option market interval.

Arrow **2330** directs the flow of execution from starting operation **2112** to operation **2332**. Operation **2332** performs determining a first bid validated

order for a first market interval agreeing with a first ask validated order for the first market interval in terms of capacity option price to create an agreed capacity option price. Arrow **2334** directs execution from operation **2332** to operation **2336**. Operation **2336** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **18B** depicts a detail flowchart of operation **2116** of Figure **10B** performing calculating an agreed option amount.

Arrow **2350** directs the flow of execution from starting operation **2116** to operation **2352**. Operation **2352** performs calculating an agreed option amount for the market interval at the agreed price and the agreed capacity option price based upon the first bid validated order and first ask validated order. Arrow **2354** directs execution from operation **2352** to operation **2356**. Operation **2356** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **18C** depicts a detail flowchart of operation **2120** of Figure **10B** performing creating the agreed contract at the agreed price and the agreed option price for the agreed amount whenever the first bid order agrees with the first ask order in terms of the price and the option price.

Arrow **2370** directs the flow of execution from starting operation **2120** to operation **2372**. Operation **2372** performs creating the agreed contract for the market interval at the agreed price and the agreed option price for the agreed amount whenever the first bid validated order agrees with the first ask validated order in terms of the price and the option price. Arrow **2374** directs

execution from operation **2372** to operation **2376**. Operation **2376** terminates the operations of this flowchart.

In certain embodiments, these operations are supported by a program code segment residing in a coupled computer readable memory on at least one computer in a computing system supporting a virtual trading floor for ephemeral, fungible commodities.

Figure **19A** depicts a market state **1102** associated with a market interval **1100** as show in Figures **3A**, **13** and **17B** in accordance with certain embodiments.

In certain embodiments, market state **1102** includes a price **1102-1**. In certain further embodiments, where market state **1102** is associated with a market interval **1100** containing a capacity option type **1118** as shown in Figure **17B**, market state **1102** may further contain a capacity option price **1102-2**.

Figure **19B** depicts a detail flowchart of operation **2004** of Figure **17A** performing calculating the capacity option price **1102-2** for the market state **1102** as shown in Figure **19A** of a market interval as shown in Figure **17B** containing a capacity option **1118**.

Arrow **2390** directs the flow of execution from starting operation **2004** to operation **2392**. Operation **2392** performs calculating the associated capacity option market price of each market interval based upon the bid validated orders of the validated order collection for the market interval and the ask validated orders of the validated order collection for the market interval. Arrow **2394** directs execution from operation **2392** to operation **2396**. Operation **2396** terminates the operations of this flowchart.

Figure **20** depicts a method of controlling the interaction between a client **1400** and a virtual trading floor comprising maintaining a session component **3300**, participant component **3320** and market segment **3340** in accordance with certain embodiments.

In certain further embodiments, maintaining the session component **3300** comprises the following: Receiving an order request message **3302** from client **2190**. Sending the received order request message **3322** to the participant component **3320** to create a forwarded order request message for the participant component. Receiving **3324** the acknowledgement message based upon the validated order request message and the relevant client list message for the validated order request message. Processing the received acknowledgement message and relevant client list for the validated order request message to create a broadcast update message for the validated order request message. Sending the broadcast update message **3304** to each of the clients **2190** of the relevant client list.

In certain further embodiments, maintaining the participant component **3320** comprises the following: Receiving the forwarded order request message **3302** from the session component. Maintaining **3332** a participant database **3330**. Validating the received, forwarded order request message. And responding to the validated order request message whenever the received, forwarded order request message is validated.

In certain further embodiments, maintaining the participant database comprises the following: Adding the received, forwarded order request message **3332** to the participant database **3330**. Validating the received, forwarded ordered request message requires examining **3324** and **3322** the session database based upon the received, forwarded order request message to create a validated order request message.

In certain further embodiments, responding to a validated message comprises the participant component performing the following activities: Sending an acknowledgement message **3324** based upon the validated order request message to the session component **3300**. Assembling a list of relevant clients for the validated order request message and sending **3324** the session component **3300** a relevant client list message for the validated order request

message. Sending a market order request message **3342** to the market segment **3340** based upon the validated order request message.

In certain further embodiments, maintaining the market segment **3340** comprises performing the following activities: Receiving the market order request message **3342**. Maintaining **3352** a market segment database **3350** comprised of market intervals with associated market states as either active or closed. The market state of an active market interval comprises the total pending buy-position and the total pending sell-position.

In certain further embodiments, maintaining the market segment database **3350** comprises performing the following activities: Updating the market state of at least one market interval **3352** based upon the received market order request message **3342**. Reconciling the total pending buy-position with the total pending sell-position of at least one market interval. Closing a market interval.

In certain further embodiments, a virtual trading mechanism database comprising a read-only database **3360** for market configuration and for participant configuration by the virtual trading mechanism. In certain embodiments, settlement and schedule databases are not directly accessed by the virtual trading mechanism.

Figure **21** depicts a refinement of computing system **3000** as a system diagram in Figure **15** in accordance with certain further embodiments. This computing system is comprised of a client computer collection and a server system **3500** coupled to a network **3200**.

As shown in Figure **15**, the client computer collection is comprised of at least one client computer **3600** operated **3192** by certified client **1400**. In certain further embodiments, client computer **2610** operated **3104** by a human being as client **3100**. In certain other further embodiments, client computer **2620** operated **3124** by a corporate entity as client **3120**. In certain other further embodiments, client computer **2630** operated **3144** by an authorized agent as

client **3140**. The certified client is represented by an agent authorized by the first party to act on behalf of the first party with respect to contracting the AC power transfer.

As shown in Figure **15**, server system **3500** includes at least one server computer **3520** coupled to network **3200**. Network **3200** further couples **3602**, **3612**, **3622**, **3632** and **3642** to client computers **3600**, **3610**, **3620**, **3630** and **3640**, respectively. Network **3200** at least supports communication between client computers and at least one server computer **3520** of server system **3500**. As used herein, the term network refers not only to Local Area Networks (LANs), but also to Wide Area Networks (WANs). Network supported communication as used herein includes, but is not limited to, digital communication protocols as well as analog communication protocols. Network supported communication as used herein further includes, but is not limited to, message passing protocols and packet based protocols. Network supported communication as used herein further includes, but is not limited to, communication protocols including TCP/IP. Network supported communication as used herein further includes, but is not limited to, communication protocols supporting the Internet. Network supported communication as used herein further includes, but is not limited to, communication protocols supporting the World Wide Web.

As shown in Figure **15**, in certain further embodiments, client computer **3610** with coupled **3614** computer readable memory **3616** operated **3104** by a client **1400** further coupled **3194** to computer readable memory **3606**. In certain further embodiments, client computer **3640** with coupled **3644** computer readable memory **3646** operated **3164** by a software agent as client **3160**. In certain other further embodiments, the coupling **3194** provides various personal optimizations and shortcuts, including but not limited to macro style functions and standard contract forms employed by the client **1400**.

In certain other further embodiments, server system **3500** includes at least one server computer **3520** coupled **3524** to computer readable memory **3526**.

As shown in Figure **15**, server system **2500** includes a server computer **3520** coupled **3528** to network **3200**. In certain further embodiments, server system **3500** includes server computer **3530** coupled **3538** to network **3200**. In certain further embodiments, server system **3500** includes server computer **3540** coupled **3548** to network **3200**. In certain further embodiments, server system **3500** includes server computer **3550** coupled **3558** to network **3200**. Note that in other further embodiments, even more server computers may be coupled to the network.

As shown in Figure **15**, network **3200** further couples **3602**, **3612**, **3632**, **3632** and **3642** to client computers **3600**, **3610**, **3620**, **3630** and **3640**, respectively. Network **3200** at least supports communication between client computers and at least one server computer **3520** of server system **3500**. As used herein, the term network refers not only to Local Area Networks (LANs), but also to Wide Area Networks (WANs). Network supported communication as used herein includes, but is not limited to, digital communications protocols as well as analog communication protocols. Network supported communication as used herein further includes, but is not limited to, message passing protocols and packet based protocols. Network supported communication as used herein further includes, but is not limited to, communication protocols including TCP/IP. Network supported communication as used herein further includes, but is not limited to, communication protocols supporting the Internet. Network supported communication as used herein further includes, but is not limited to, communications protocols supporting the World Wide Web.

As shown in Figure **15**, in certain further embodiments, client computer **3610** with coupled **3614** computer readable memory **3616** is operated **3104** by a client **3100** further coupled **3194** to computer readable memory **3606**. In certain further embodiments, client computer **3640** with coupled **3644** computer readable memory **3646** is operated **3164** by a software agent as client **3160**. In certain other further embodiments, the coupling **3194** provides various personal optimizations and shortcuts, including, but not limited to,

macro style functions and standard contract forms employed by the client **3190**.

As shown in Figure **15**, in certain other further embodiments, server system **3500** includes at least one server computer **3520** coupled **3524** to computer readable memory **3526**. Additionally, in certain further embodiments, server system **3500** includes server computer **3530** coupled **3534** to computer readable memory **3536**. Additionally, in certain further embodiments, server system **3500** includes server computer **3540** coupled **3544** to computer readable memory **3546**. Additionally, in certain further embodiments, server system **3500** includes server computer **3550** coupled **3554** to computer readable memory **3556**.

Note that in certain further embodiments, server computer coupled computer readable memory may contain a read-write accessible memory. Note that in certain further embodiments, the read-write accessible memory may contain at least one mass storage unit. In certain further embodiments, a mass storage unit may include a disk drive. In certain embodiments, a mass storage unit may be accessed using a file management system. In certain embodiments, a mass storage unit may be accessed as a database.

Certain embodiments include a method of operating a client computer with a client computer message address interfaced with a reliable distributed system composed of a server system containing server computers with associated messaging addresses. The method includes a login procedure, a message composition procedure for an outgoing message to the reliable distributed system, and a message analysis procedure for an incoming message from the reliable distributed system.

In certain further embodiments, the login procedure maintains a list of messaging addresses of the collection of computers of the distributed system, a first login message and a login protocol and performs the following:

a. A first server computer of the server system is selected, and a first login message is sent to the associated address of the first server computer.

b. If there is a first acknowledgement message received from the first server computer message address then the login procedure proceeds to perform the login protocol.

c. Whenever the login protocol fails with the first server computer or

- whenever there is no acknowledgement message received from the first server computer within a predetermined amount of time or
- whenever there remain server computers in the server system for which login has not been attempted,
- the first server computer is selected from the remaining server computers of the server system and these steps are repeated.

d. Whenever the login protocol succeeds with the first server computer, the first server computer is designated the connection computer.

In certain further embodiments, the message composition procedure for an outgoing message to the distributed system comprises performing the following: Maintaining a list of message formats. Determining the selection of a first message format. Using the first message format to create an outbound message. Sending the outbound message to the connection computer.

In certain further embodiments, the message analysis procedure for an incoming message from the distributed system comprises performing the following: Receiving the message from the connection computer. Validating the received message creates a valid received message.

Certain embodiments employ an object class structure supporting message passing, each message comprises a message type and at least one message field. Each message-passing object comprises handling an unknown message type and handling for an unknown message field.

In certain further embodiments, handling an unknown message type for a received message from a first object by a second object comprises the first

object sending the second object a reply message indicating unknown received message type and referencing the received message.

In certain further embodiments, handling an unknown message field of the received message by the second object comprises handling the other fields of the received message by the second object.

Certain embodiments employ a method of operating a reliable distributed system of a collection containing at least one process group running on several computers comprising receiving confirmed messages from certified clients and maintaining a group state. Each process group computer possesses a messaging address. The computers of a process group communicate amongst themselves with a virtually synchronous messaging system.

In certain further embodiments, receiving a confirmed message from a certified client occurs at one computer of the first collection of computers running the process group. Upon receipt the receiving computer broadcasts the confirmed message from the certified client to all computers of the first collection of computers.

In certain further embodiments, maintaining a group state on each computer of the first collection of computers of the process group comprising the following operations: Each computer processes the confirmed message from the certified client to create a group state candidate. Each computer broadcasting a virtually synchronous group state candidate message to the other computers. Each computer receives the virtually synchronous group state candidate messages of the other computers. Each computer analyzes the received virtually synchronous group state candidate messages and its own virtually synchronous group state candidate to create a new group state.

Certain embodiments employ a messaging system for message passing concurrent objects, instances of which reside on computers each possessing a controller belonging to a collection of computers comprising ABCAST

protocol and GBCAST protocol. The ABCAST protocol is an atomic broadcast protocol used to communicate messages between object instances across the computers of the collection of computers. The GBCAST protocol is a global broadcast protocol to communicate messages between controllers of the computers of the collection of computers.

Certain embodiments employ an object class structure executing in a process group of computers communicating with each other via a messaging protocol supporting at least virtual synchrony. Each instance of each object of the object class structure comprises an object instance clone reading on each of the process group computers.

In certain further embodiments, each object instance may send and receive messages from other object instances and each object instance clone communicates with messages to other object instance clones of the same object instance.

In certain further embodiments, each object class possesses a state, which is a member of a collection of states. Each instance of each object class state changes as an atomic event. All activities of each object class occur as atomic events. Atomic events may be triggered by message reception. State changes in an object instance clone trigger transmission of a state change message to other object instance clones of the same object instance.

In certain embodiments, a concurrent computing entity resides on each of the computers of a process group of computers where it owns access to a binary file used for storing the resilient object instance state. It executes updates to the binary file as a transaction. The storage in the binary file is organized into table objects. Each table object consists of a set of records.

Figure **22** depicts a view of a certified client user interface operating on a client computer showing an ordering screen with hourly time interval based market intervals for a specific energy market in accordance with certain embodiments.

In certain embodiments, a client display screen **4000** interactively shows the market state of a number of related market intervals. In certain further embodiments, client display screen **4000** indicates the market state of market intervals sharing the same product type **4004** and location **4002** and for successive time intervals **4004** for November 11, 1998 as indicated by highlighted lettering in calendar **4030**.

The column **4006** labeled "Market Time Hour Ending (ST)" has a succession of rows with entries from 1 to 24, indicating the hourly energy markets **4004** in the Illinois sell zone **4002**. Consider the row labeled by the hour **4008** ending at "3". This row displays the market state of the market interval with energy product type, Illinois sell zone location and hour time interval ending at 3:00 for November 11, 1998. The current market price in dollars per megawatt-hour **4010** is "12.96". The contracted position in net megawatts **4012** is "12.00". The pending position in net megawatts **4014** is "13.00". The total position in net megawatts **4016** is "25.00", which is the sum of the contract and pending positions for that market interval. The highest bid quantity in net megawatts-hours **4018** is "26.98". The highest bid price in dollars per megawatt-hour **4020** is "11.71". The highest ask quantity in net megawatts-hours **4022** is "38.84". The highest ask price in dollars per megawatt-hour **4024** is "14.21".

Figure **23** depicts a view of a certified client user interface operating on a client computer showing an ordering screen for daily on-peak time interval based market intervals for a specific energy market in accordance with certain embodiments.

In certain embodiments, a client display screen **4100** interactively shows the market state of a number of related market intervals. In certain further embodiments, client display screen **4100** indicates the market state of market intervals sharing the same product type **4104** and location **4102** and for successive time intervals **4104** from November 7, 1998 to November 24, 1998

as indicated by highlighted lettering in calendar **4130**. Consider the row for 11/12/1998.

The column labeled "Market Time Day Ending" has a succession of rows with entries from 11/07/1998 to 11/23/1998, indicating the daily on peak energy markets **4104** in the Illinois sell zone **4102**.

The current market price in dollars per megawatt-hour **4110** is "16.72". The contracted position in net megawatts **4112** is "10.00". The pending position in net megawatts **4114** is "0.00". The total position in net megawatts **4116** is "10.00", which is the sum of the contract and pending positions for that market interval. The highest bid quantity in net megawatts-hours **4118** is "25.50". The highest bid price in dollars per megawatt-hour **4120** is "20.61". The highest ask quantity in net megawatts-hours **4122** is "35.50". The highest ask price in dollars per megawatt-hour **4124** is "23.28".

Figure **24** depicts a view of a certified client user interface operating on a client computer showing an ordering screen for hourly time interval based market intervals for a specific flow gate market in accordance with certain embodiments.

The displayed information **4200** includes a variety of fields, including field **4202**, where a specific flow gate or intertie may be selected. Immediately below that field is a field which specifies commodity type, in this case, "Hourly Flowgate". The column indicated by **4210** represents the current market price. The column to its right indicates the amount of the commodity already awarded. The box **4206** points to two columnar components. The left component represents the auction bid quantity and the right component represents the bid price per unit quantity on each row. Note that each row represents a distinct market interval, trading independently of the other market intervals.

In certain embodiments, a client display screen **4200** interactively shows the market state of a number of related market intervals. In certain further

embodiments, client display screen **4200** indicates the market state of market intervals sharing the same product type **4204** and location **4202** and for successive time intervals for May 10, 1999 as indicated by highlighted lettering in calendar **4230**.

The column labeled "Market Time Hour Ending (DT)" has a succession of rows with entries from 1 to 24, indicating the hourly AC power transfer markets **4204** in the flow gate location "COCOPP_7_Unit 1" **4202**. Consider the row labeled by the hour **4208** ending at "3". This row displays the market state of the market interval with AC power transfer product type, flow gate **4202** location and hour time interval ending at 1:00 for May 10, 1999. The current market price in dollars per megawatt-hour **4210** is "0.00". The contracted position in net megawatts **4212** is "0.00". The pending position in net megawatts **4214** is "0.00". The total position in net megawatts **4216** is "0.00", which is the sum of the contract and pending positions for that market interval. The contracted flow **4224** is "0.00". The pending flow **4226** is "0.00". The total flow **4228** is "0.00".

The preceding embodiments have been provided by way of example and are not meant to constrain the scope of the following claims.

Claims

1. A method for trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network each containing a node collection of at least two nodes comprising

maintaining a market interval collection of market intervals; and

maintaining a validated order collection of validated orders, each with an associated market interval;

wherein each of said validated orders of said validated order collection contains an order type belonging to an order type collection comprising a bid validated order for said associated market interval and an ask validated order for said associated market interval;

wherein each of said market intervals of said market interval collection contains a product type, a location, and a time interval;

wherein said product type of each of said market intervals of said market interval collection is a member of a product type collection comprised of energy and AC power transfer;

wherein said location of a market interval of said market interval collection having said energy product type is a first of said nodes of said node collection of an AC power network contained in said power grid; and

wherein said location of a market interval of said market interval collection having said AC power transfer energy product type is from a first of said nodes of said node collection of a first AC power network contained in said power grid to a second of said nodes of said node collection of said first AC power network.

2. The method of Claim 1,

wherein said validated order may comprise multiple validated orders, each with said associated market interval; and

wherein said multiple validated orders may further comprise at least one of the collection comprised of

multiple validated orders for market intervals which differ in location; and

multiple validated orders for market intervals which differ in product type.

3. The method of Claim 2,

wherein an AC power network contained in said electrical power grid further contains a flow gate collection of flow gates, each flow gate location being from an associated first node of said AC power network to an associated second node of said AC power network;

wherein for each of said flow gates of said flow gate collection, there is at least one associated market interval in said market interval collection of AC power transfer product type with said flow gate location.

4. The method of Claim 1,

wherein said electrical power grid further contains a DC power line collection of at least one DC power line at location of said DC power line from a first node of a first AC power network to a second node of a second AC power network;

wherein said product type collection further comprises DC power transfer; and

wherein for each DC power line of said DC power line collection, there is at least one associated market interval with DC power transfer product type, with said location as said location of said DC power line.

5. The method of Claim 1,

wherein each market interval further contains a window time interval during which said market interval is active only within said window time interval; and

wherein said window time interval of said market interval entirely occurs before said time interval contained in said market interval for each of said market intervals of said market interval collection.

6. The method of Claim 5,

wherein a first of said market intervals of said market interval collection may contain a first time interval and a second time interval not overlapping said first time interval; and

wherein said window time interval of said market intervals entirely occurs before said associated first time interval of said first market interval; and

wherein said window time interval of said first market interval entirely occurs before said associated second time interval of said first market interval.

7. The method of Claim 5, further comprising

establishing a real time;

wherein maintaining said validated order collection of said validated orders comprises

determining whether said real time is contained in said window time interval for said associated market interval of said validated order of said validated order collection; and

removing said validated order from said validated order collection whenever said real time is not contained in said window time interval for said associated market interval of said validated order.

8. The method of Claim 1, further comprising

contracting to create an agreed contract from said validated order collection comprising

determining a first bid validated order associated with a first of said market intervals of said market interval collection agreeing with a first ask validated order associated with said first market interval in terms of price to create an agreed price;

calculating an agreed amount for said first market interval at said agreed price based upon said first bid validated order and first ask validated order; and

creating said agreed contract for said first market interval at said agreed price for said agreed amount whenever said first bid validated order agrees with said first ask validated order in terms of said price.

9. The method of Claim 8,

wherein maintaining said validated order collection of said validated orders further comprises at least one of the collection comprising

removing said first bid validated order from said validated order collection; and

removing said first ask validated order from said validated order collection.

10. The method of Claim 9,

wherein said first bid validated order is contained in a validated order further containing a second validated order;

wherein removing said first bid validated order from said validated order collection comprises removing said first bid validated order from said validated order.

11. The method of Claim 9,

wherein said first ask validated order is contained in a validated order further containing a second validated order; and

wherein removing said first ask validated order from said validated order collection comprises removing said first ask validated order from said validated order.

12. The method of Claim 8, further comprising

maintaining a certified client collection of certified clients;

wherein each of said validated orders of said validated order collection contains an ordering client of said certified client collection;

wherein maintaining said validated order collection of said validated orders further comprises

15. The method of Claim 14,

wherein said market interval of said market interval collection may further contain a capacity option type;

wherein said validated order of said validated order collection with a first of said associated market intervals containing said capacity option type further comprises a capacity option price;

wherein determining said first bid validated order for said first market interval agreeing with said first ask validated order for said first market interval in terms of price to create said agreed price comprises

determining said first bid validated order for said first market interval agreeing with said first ask validated order for said first market interval in terms of capacity option price to create an agreed capacity option price;

wherein calculating an agreed amount for said market interval at said agreed price based upon said first bid validated order and first ask validated order comprises

calculating an agreed option amount for said market interval at said agreed price and said agreed capacity option price based upon said first bid validated order and first ask validated order;

wherein creating said agreed contract for said market interval at said agreed price and said agreed option price for said agreed amount includes

creating said agreed contract for said market interval at said agreed price and said agreed option price for said agreed amount whenever said first bid validated order agrees with said first ask validated order in terms of said price and said option price.

16. The method of Claim 15,

wherein for each of said market intervals of said market interval collection containing said capacity option type, said associated market state further contains an associated capacity option market price;

wherein maintaining said market interval collection of market intervals, further comprises

calculating said associated capacity option market price of each market interval containing said capacity option type based upon said bid validated

receiving an order message from a first of said certified clients of said certified client collection to create a received order message from said first certified client;

processing said received order message from said first certified client to create a first processed order from said first certified client; and

inserting said first processed order from said first certified client into said validated order collection to create a validated order containing said first certified client as said order client contained in said validated order collection.

13. The method of Claim 12,

wherein contracting to create said agreed contract from said validated order collection further comprises

extracting from said first bid validated order to create a bid certified client;

extracting from said ask validated order to create an ask certified client;

sending a bid contract message based upon said agreed contract to said bid client;

sending an ask contract message based upon said agreed contract to said ask client.

14. The method of Claim 8,

wherein each of said market intervals of said market interval collection has an associated market state comprising a market price for said market interval product type at said market interval location during said market interval time interval;

maintaining said market interval collection of market intervals, further comprises calculating said associated market price of each of said market intervals of said market interval collection based upon said bid validated orders of said validated order collection for said market interval and said ask validated orders of said validated order collection for said market interval.

orders of said validated order collection for said market interval and said ask validated orders of said validated order collection for said market interval.

17. A program operating system composed of program code segments residing in computer readable memory coupled to at least one computer supporting a method for trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network each containing a node collection of at least two nodes comprising,

a program code segment supporting maintaining a market interval collection of market intervals; and

a program code segment maintaining a validated order collection of validated orders, each with an associated market interval;

wherein each of said validated orders of said validated order collection contains an order type belonging to an order type collection comprising a bid validated order for said associated market interval and an ask validated order for said associated market interval;

wherein each of said market intervals of said market interval collection contains a product type, a location, and a time interval; and

wherein each of said market intervals of said market interval collection has an associated market state comprising a market price for said market interval product type at said market interval location during said market interval time interval;

wherein each of said product type of each of market intervals of said market interval collection is a member of a product type collection comprised of energy and AC power transfer;

wherein said location of a market interval of said market interval collection having said energy product type is a first of said nodes of said node collection of an AC power network contained in said power grid; and

wherein said location of a market interval of said market interval collection having said AC power transfer energy product type is from a first node of said node collection of a first AC power network contained in said power grid to a second node of said node collection of said first AC power network.

18. The program operating system of Claim 17,

wherein said validated order may comprise multiple validated orders, each with said associated market interval; and

wherein said multiple validated orders may further comprise at least one of the collection comprised of:

multiple validated orders for market intervals which differ in location; and

multiple validated orders for market intervals which differ in product type.

19. The program operating system of Claim 18,

wherein an AC power network contained in said electrical power grid further contains a flow gate collection of flow gates, each flow gate location being from an associated first node of said AC power network to an associated second node of said AC power network;

wherein for each of said flow gates of said flow gate collection, there is at least one associated market interval in said market interval collection of AC power transfer product type with said flow gate location.

20. The program operating system of Claim 17,

wherein said electrical power grid further contains a DC power line collection of at least one DC power line at location of said DC power line from a first node of a first AC power network to a second node of a second AC power network;

wherein said product type collection further comprises DC power transfer; and

wherein for each DC power line of said DC power line collection, there is at least one associated market interval with DC power transfer product type, with said location as said location of said DC power line.

21. The program operating system of Claim 17,

wherein each market interval further contains a window time interval during which said market interval is active only within said window time interval; and

wherein said window time interval of said market interval entirely occurs before said time interval contained in said market interval for each of said market intervals of said market interval collection.

22. The program operating system of Claim 21,

wherein a first of said market intervals of said market interval collection may contain a first time interval and a second time interval not overlapping said first time interval; and

wherein said window time interval of said market intervals entirely occurs before said associated first time interval of said first market interval; and

wherein said window time interval of said first market interval entirely occurs before said associated second time interval of said first market interval.

23. The program operating system of Claim 21, further comprising

a program code segment supporting establishing a real time; and

wherein said program code segment supporting maintaining said validated order collection of said validated orders comprises:

a program code segment determining whether said real time is contained in said window time interval for said associated market interval of said validated order of said validated order collection; and

a program code segment supporting removing said validated order from said validated order collection whenever said real time is not contained in said window time interval for said associated market interval of said validated order.

24. The program operating system of Claim 17, further comprising

a program code segment supporting contracting to create an agreed contract from said validated order collection comprising:

a program code segment supporting determining a first bid validated order associated with a first of said market intervals of said market interval collection agreeing with a first ask validated order associated with said first market interval in terms of price to create an agreed price;

a program code segment supporting calculating an agreed amount for said first market interval at said agreed price based upon said first bid validated order and first ask validated order;

a program code segment supporting creating said agreed contract for said first market interval at said agreed price for said agreed amount whenever said first bid validated order agrees with said first ask validated order in terms of price.

25. The program operating system of Claim 24,

wherein said program code segment supporting maintaining said validated order collection of said validated orders further comprises at least one of the collection comprising:

a program code segment supporting removing said first bid validated order from said validated order collection; and

a program code segment supporting removing said first ask validated order from said validated order collection.

26. The program operating system of Claim 25,

wherein said first bid validated order is contained in a validated order containing a second validated order;

wherein said program code segment supporting removing said first bid validated order from said validated order collection comprises a program code segment supporting removing said first bid validated order from said validated order.

27. The program operating system of Claim 25,

wherein said first ask validated order is contained in a validated order containing a second validated order;

wherein said program code segment supporting removing said first ask validated order from said validated order collection comprises a program code segment supporting removing said first ask validated order from said validated order.

28. The program operating system of Claim 24, further comprising

A program code segment supporting maintaining a certified client collection of certified clients; and

wherein each of said validated orders of said validated order collection contains an ordering client of said certified client collection; and

wherein said program code segment supporting maintaining said validated order collection of said validated orders further comprises

a program code segment supporting receiving an order message from a first of said certified clients of said certified client collection to create a received order message from said first certified client;

a program code segment supporting processing said received order message from said first certified client to create a first processed order; and

a program code segment supporting inserting said first processed order into said validated order collection.

29. The program operating system of Claim 28,

wherein said program code segment supporting contracting to create an agreed contract from said validated order collection further comprises

a program code segment supporting extracting from said first bid validated order to create a bid certified client;

a program code segment supporting extracting from said ask validated order to create an ask certified client;

a program code segment supporting sending a bid contract message based upon said agreed contract to said bid client; and

a program code segment supporting sending an ask contract message based upon said agreed contract to said ask client.

30. The program operating system of Claim 24,

wherein each of said market intervals of said market interval collection has an associated market state comprising a market price for said market interval product type at said market interval location during said market interval time interval;

said program code segment supporting maintaining said market interval collection of said market intervals, further comprises

a program code segment supporting calculating said associated market price of each market interval based upon said bid validated orders of said validated order collection for said market interval and said ask validated orders of said validated order collection for said market interval.

31. The program operating system of Claim 30,

wherein at least one of said market intervals of said market interval collection may further contain a capacity option type;

wherein said validated order of said validated order collection with a first of said associated market intervals containing said capacity option type further comprises a capacity option price;

wherein said program code segment supporting determining said first bid validated order for said first market interval agreeing with said first ask validated order for said first market interval in terms of price to create said agreed price comprises

a program code segment supporting determining said first bid validated order for said first market interval agreeing with said first ask validated order for said first market interval in terms of capacity option price to create said agreed capacity option price;

wherein said program code segment supporting calculating said agreed amount for said market interval at said agreed price based upon said first bid validated order and said first ask validated order comprises

a program code segment supporting calculating an agreed option amount for said market interval at said agreed price and said agreed capacity option price based upon said first bid validated order and said first ask validated order;

said program code segment supporting creating said agreed contract for said market interval at said agreed price and said agreed option price for said agreed amount comprises

said program code segment supporting creating said agreed contract for said market interval at said agreed price and said agreed option price for said agreed amount whenever said first bid validated order agrees with said first ask validated order in terms of price and option price.

32. The program operating system of Claim 31,

wherein for each of said market intervals of said market interval collection containing said capacity option type, said associated market state further contains an associated capacity option market price; and

wherein said program code segment supporting maintaining a market interval collection of market intervals, further comprises

a program code segment supporting calculating said associated capacity option market price of each market interval containing said capacity option type based upon said bid validated orders of said validated order collection for said market interval and said ask validated orders of said validated order collection for said market interval.

33. A computing system supporting a method for trading ephemeral, fungible commodities of an electrical power grid containing at least one AC power network each containing a node collection of at least two nodes, comprising:

at least one computer coupled to a computer readable memory supporting a program operating system composed of program code segments residing in said computer readable memory coupled to at least one of said computer;

wherein said program operating system is comprised of:

a program code segment supporting maintaining a market interval collection of market intervals; and

a program code segment maintaining a validated order collection of validated order, each with an associated market interval;

wherein each of said validated orders of said validated order collection contains an order type belonging to an order type collection comprising a bid validated order for said associated market interval and an ask validated order for said associated market interval; and

wherein each of said market intervals containing a product type, a location, and a time interval; and

wherein each of said market intervals has an associated market state comprising a market price for said market interval product type at said market interval location during said market interval time interval;

wherein each of said product type of each of said market intervals of said market interval collection is a member of a product type collection comprised of energy and AC power transfer;

wherein said location of a market interval of said market interval collection having said energy product type is a first of said nodes of said node collection of an AC power network contained in said power grid; and

wherein said location of a market interval of said market interval collection having said AC power transfer energy product type is from a first node of said node collection of a first AC power network contained in said power grid to a second node of said node collection of said first AC power network.

34. The computing system of Claim 33,

wherein said validated order of said validated order collection may comprise multiple validated orders, each with said associated market interval; and

wherein said multiple validated orders may further comprise at least one of the collection comprised of

multiple validated orders for market intervals which differ in location; and

multiple validated orders for market intervals which differ in product type.

35. The computing system of Claim 34,

wherein an AC power network contained in said electrical power grid further contains a flow gate collection of flow gates, each flow gate location being from an associated first node of said AC power network to an associated second node of said AC power network;

wherein for each of said flow gates of said flow gate collection, there is at least one associated market interval in said market interval collection of AC power transfer product type with said flow gate location.

36. The computing system of Claim 33,

wherein said electrical power grid further contains a DC power line collection of at least one DC power line at location of said DC power line from a first node of a first AC power network to a second node of a second AC power network;

wherein said product type collection further comprises DC power transfer; and

wherein for each DC power line of said DC power line collection, there is at least one associated market interval with DC power transfer product type, with said location as said location of said DC power line.

37. The computing system of Claim 33,

wherein each market interval further contains a window time interval during which said market interval is active only within said window time interval; and

wherein said window time interval of said market interval entirely occurs before said time interval contained in said market interval for each of said market intervals of said market interval collection.

38. The computing system of Claim 37,

wherein a first of said market intervals of said market interval collection may contain a first time interval and a second time interval not overlapping said first time interval; and

wherein said window time interval of said market intervals entirely occurs before said associated first time interval of said first market interval; and

wherein said window time interval of said first market interval entirely occurs before said associated second time interval of said first market interval.

39. The computing system of Claim 37,

wherein said program operating system further comprises

a program code segment supporting establishing a real time; and

wherein said program code segment supporting maintaining said validated order collection of said validated orders further comprises:

a program code segment supporting determining whether said real time is contained in said window time interval for said associated market interval of said validated order of said validated order collection; and

a program code segment supporting removing said validated order from said validated order collection whenever said real time is not contained in said window time interval for said associated market interval of said validated order.

40. The computing system of Claim 33,

wherein said program operating system further comprises

a program code segment supporting contracting to create an agreed contract from said validated order collection comprising;

a program code segment supporting determining a first bid validated order associated with a first of said market intervals of said market interval collection agreeing with a first ask validated order associated with said first market interval in terms of price to create an agreed price;

a program code segment supporting calculating an agreed amount for said first market interval at said agreed price based upon said first bid validated order and first ask validated order; and

a program code segment supporting creating said agreed contract for said first market interval at said agreed price for said agreed amount

whenever said first bid validated order agrees with said first ask validated order in terms of price.

41. The computing system of Claim 40,

wherein said program code segment supporting maintaining said validated order collection of said validated orders further comprises at least one of the collection comprising:

a program code segment supporting removing said first bid validated order from said validated order collection; and

a program code segment supporting removing said first ask validated order from said validated order collection.

42. The computing system of Claim 41,

wherein said first bid validated order is contained in a validated order containing a second validated order; and

wherein said program code segment supporting removing said first bid validated order from said validated order collection comprises:

a program code segment supporting removing said first bid validated order from said validated order.

43. The computing system of Claim 41,

wherein said first ask validated order is contained in a validated order containing a second validated order; and

wherein said program code segment supporting removing said first ask validated order from said validated order collection comprises:

a program code segment supporting removing said first ask validated order from said validated order.

44. The computing system of Claim 40,

wherein said program operating system further comprises:

a program code segment supporting maintaining a certified client collection of certified clients; and

wherein each of said validated orders of said validated order collection contains an ordering client of said certified client collection;

wherein said program code segment supporting maintaining said validated order collection of said validated orders further comprises:

a program code segment supporting receiving an order message from a first of said certified clients of said certified client collection to create a received order message from said first certified client;

a program code segment supporting processing said received order message from said first certified client to create a first processed order; and

a program code segment supporting inserting said first processed order into said validated order collection.

45. The computing system of Claim 44, further comprising

a client computer collection of client computers coupled with computer readable memory and each client computer operated by a client;

a server system containing at least one server computer with coupled computer readable memory; and

a network coupling to each client computer of said client computer collection and to at least one of said server computers of said server system; and

wherein said program code segment supporting maintaining said certified client collection of certified clients resides on said coupled, computer readable memory of at least a first of said server computers of said server system.

46. The computing system of Claim 45,

wherein said server system further comprising a redundant server collection of server computer with coupled accessible computer memory; and

wherein said coupled accessible computer memories of each of said server computers of said redundant server collection redundantly support said program code segment maintaining a certified client collection of certified clients.

47. The computing system of Claim 46,

wherein said coupled accessible computer memories of each of said server computers of said redundant server collection redundantly support program code segments comprising at least one of a collection comprising

said program code segment supporting maintaining a market interval collection of market intervals;

said program code segment supporting maintaining said validated order collection of said validated orders; and

said program code segment supporting contracting to create an agreed contract from said validated order collection.

48. The computing system of Claim 47,

wherein said coupled accessible computer memories of each of said server computers of said redundant server collection redundantly support program code segments comprising:

said program code segment supporting maintaining a market interval collection of market intervals;

said program code segment supporting maintaining said validated order collection of said validated orders; and

said program code segment supporting contracting to create an agreed contract from said validated order collection.

49. The computing system of Claim 48,

wherein said redundant server collection of said server computers with coupled accessible computer memory implements a reliable distributed computer system.

50. The computing system of Claim 44,

wherein said program code segment supporting contracting to create said agreed contract from said validated order collection further comprises:

a program code segment supporting extracting from said first bid validated order to create a bid certified client;

a program code segment supporting extracting from said ask validated order to create an ask certified client;

a program code segment supporting sending a bid contract message based upon said agreed contract to said bid client; and

a program code segment supporting sending an ask contract message based upon said agreed contract to said ask client.

51. The computing system of Claim 44,

wherein each of said market intervals of said market interval collection has an associated market state comprising a market price for said market interval product type at said market interval location during said market interval time interval;

said program code segment supporting maintaining said market interval collection of market intervals, further comprises:

a program code segment supporting calculating said associated market price of each market interval based upon said bid validated orders of said validated order collection for said market interval and said ask validated orders of said validated order collection for said market interval.

52. The computing system of Claim 44,

wherein said market interval of said market interval collection may further contain a capacity option type;

wherein said validated order of said validated order collection with a first of said associated market intervals containing said capacity option type further comprises a capacity option price;

wherein said program code segment supporting determining said first bid validated order for said first market interval agreeing with said first ask validated order for said first market interval in terms of price to create said agreed price comprises:

a program code segment supporting determining said first bid validated order for said first market interval agreeing with said first ask validated order for said first market interval in terms of capacity option price to create an agreed capacity option price;

wherein said program code segment supporting calculating said agreed amount for said market interval at said agreed price based upon said first bid validated order and first ask validated order comprises:

a program code segment supporting calculating an agreed option amount for said market interval at said agreed price and said agreed capacity option price based upon said first bid validated order and first ask validated order;

said program code segment supporting creating said agreed contract for said market interval at said agreed price and said agreed option price for said agreed amount includes

said program code segment supporting creating said agreed contract for said market interval at said agreed price and said agreed option price for said agreed amount;

whenever said first bid validated order agrees with said first ask validated order in terms of price and option price.

53. The computing system of Claim 52,

wherein for each of said market intervals of said market interval collection containing said capacity option type, said associated market state further contains an associated capacity option market price; and

wherein said program code segment supporting maintaining a market interval collection of market intervals, further comprises:

a program code segment supporting calculating said associated capacity option market price of each market interval containing said capacity option type based upon said bid validated orders of said validated order collection for said market interval and said ask validated orders of said validated order collection for said market interval.

54. A method for trading ephemeral, fungible commodities comprising:

maintaining a market interval collection of market intervals; and

maintaining a validated order collection of validated orders, each with an associated market interval, and each containing at least one of an order type collection comprising a bid validated order for said market interval and an ask validated order for said market interval;

wherein each of said market intervals of said market interval collection contains a product type, a location, and a time interval.

55. A program operating system composed of program code segments residing in computer readable memory coupled to at least one computer supporting a method for trading ephemeral, fungible commodities comprising,

a program code segment supporting maintaining a market interval collection of market intervals; and

a program code segment maintaining a validated order collection of validated orders, each with an associated market interval, and each containing at least one of an order type collection comprising bid validated order for said market interval and ask validated orders for said market interval; and

wherein each of said market intervals of said market interval collection contains a product type, a location, and a time interval.

56. A computing system supporting a method for trading ephemeral, fungible commodities, comprising:

at least one computer coupled to a computer readable memory supporting a program operating system composed of program code segments residing in said computer readable memory coupled to at least one of said computer;

wherein said program operating system is comprised of:

a program code segment supporting maintaining a market interval collection of market intervals; and

a program code segment maintaining a validated order collection of validated orders, each with an associated market interval, and each containing at least one of an order type collection comprising bid validated order for said market interval and ask validated orders for said market interval; and

wherein each of said market intervals containing a product type, a location, and a time interval.

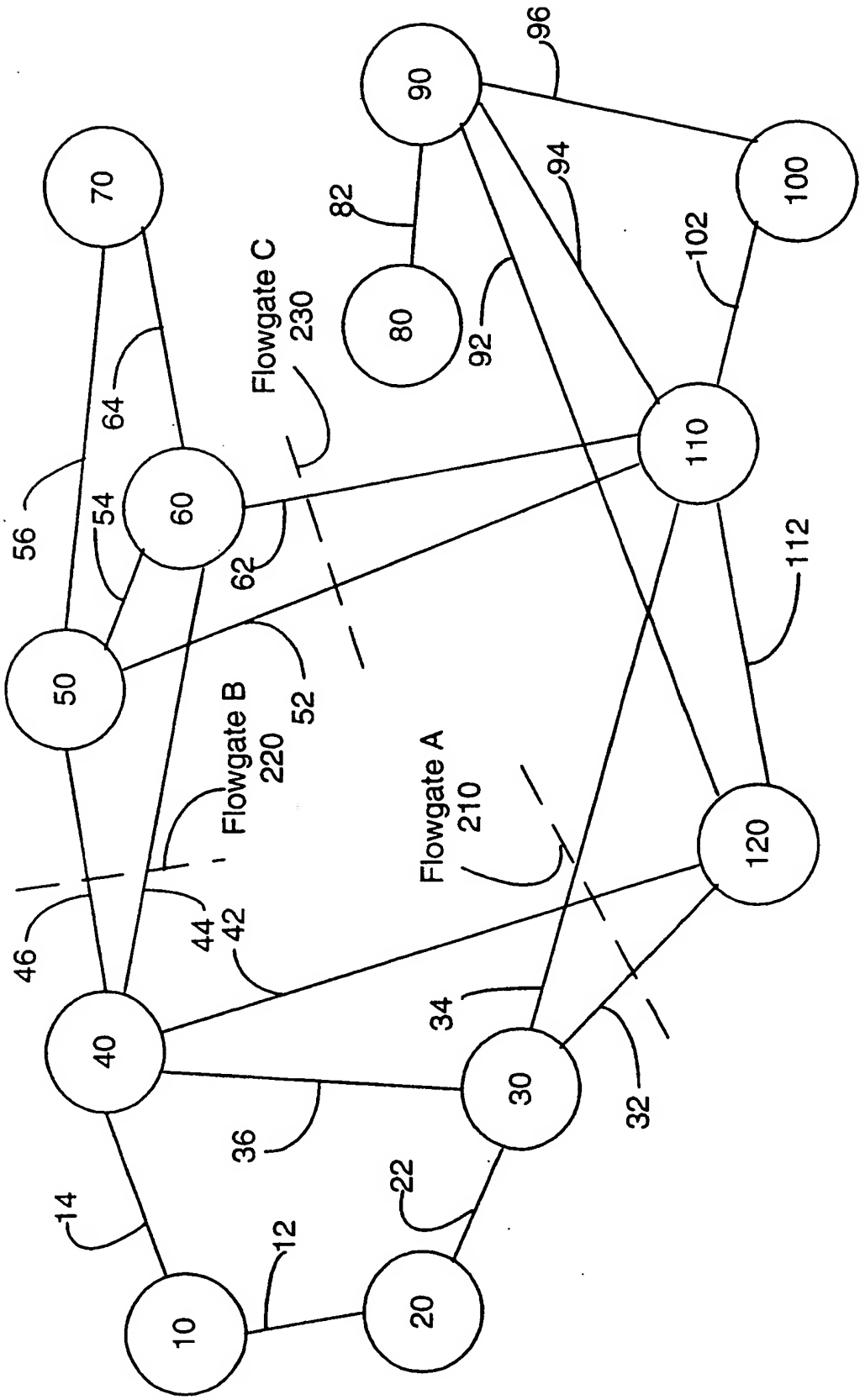


Fig. 1 Prior Art

	Flowgate		
Bus	A	B	C
1	0.70	0.30	0.30
2	0.80	0.20	0.20
3	0.90	0.10	0.10
4	0.60	0.40	0.40
5	0.60	-0.60	0.40
6	0.50	-0.50	0.50
7	0.55	-0.55	0.45
8	0.20	-0.20	-0.20
9	0.05	-0.05	-0.05
10	-0.01	0.01	0.01
11	0.00	0.00	0.00
12	-0.05	0.05	0.05

Fig. 2 Prior Art

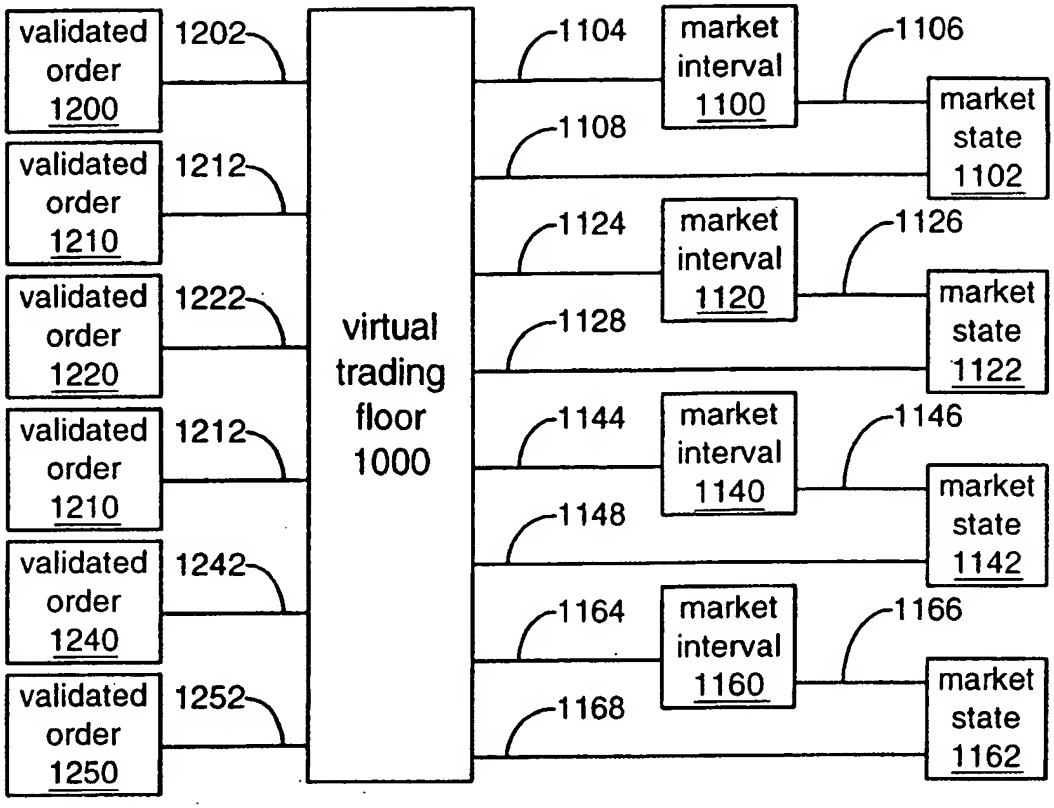


Fig. 3A

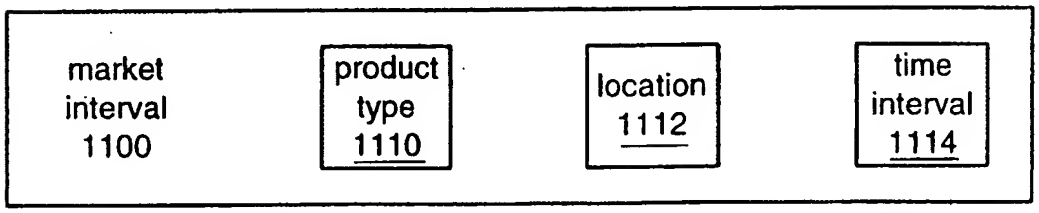


Fig. 3B

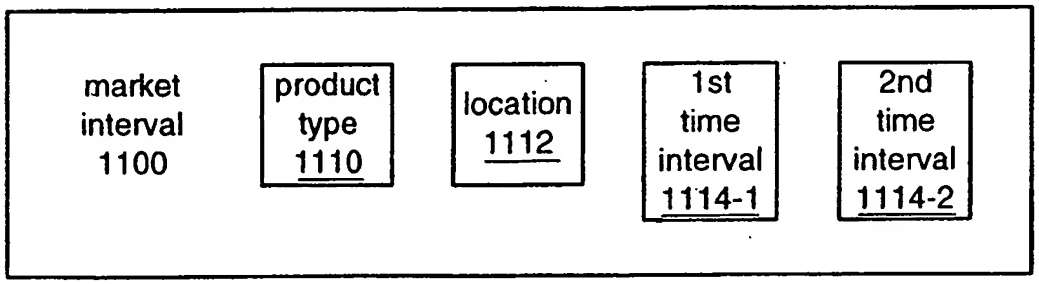


Fig. 3C

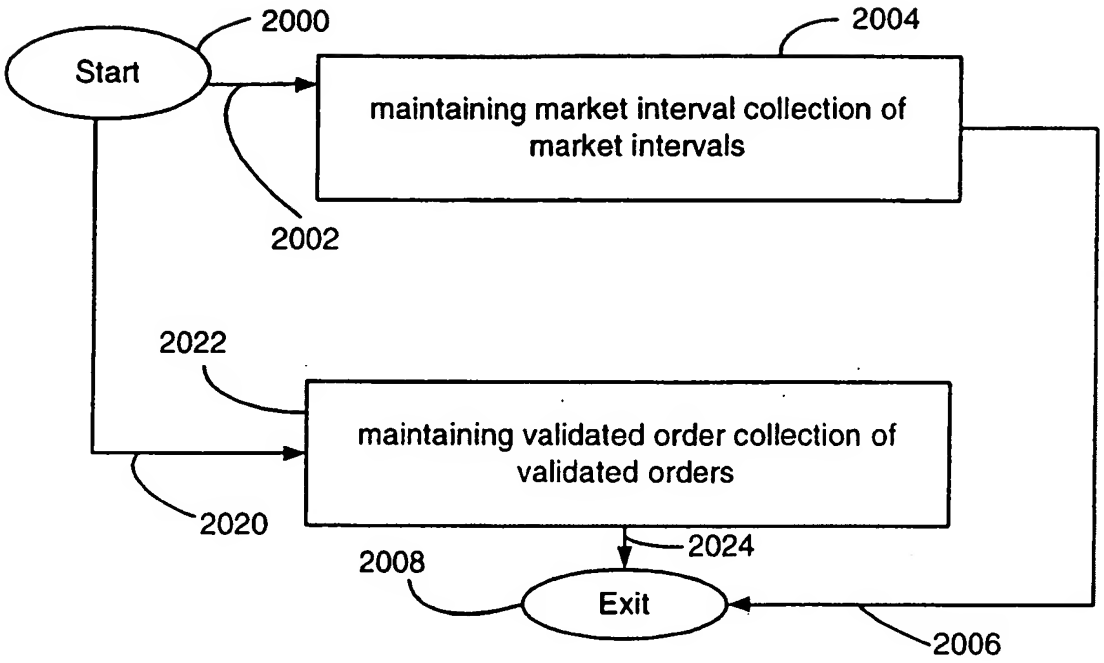


Fig. 4

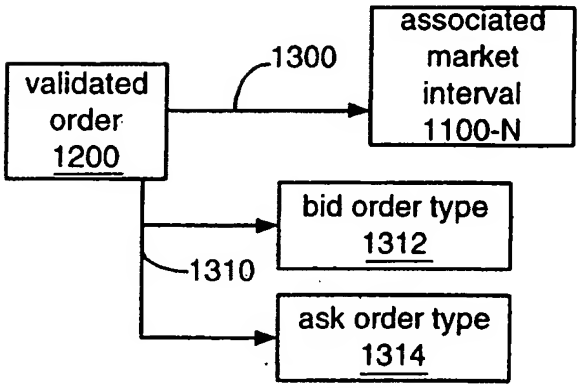


Fig. 5A

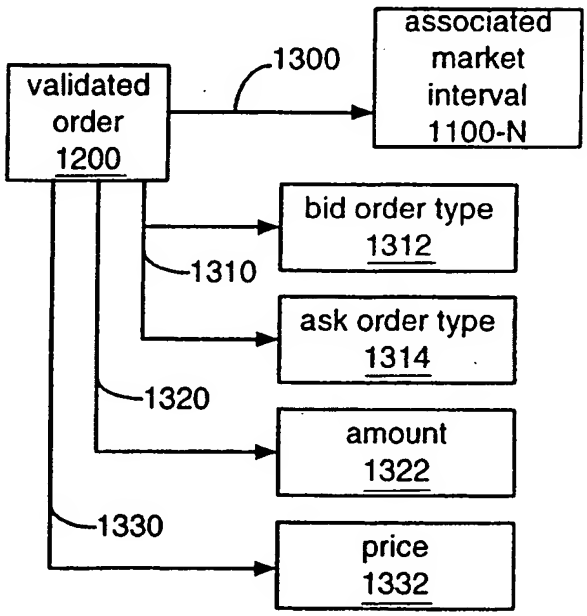


Fig. 5B

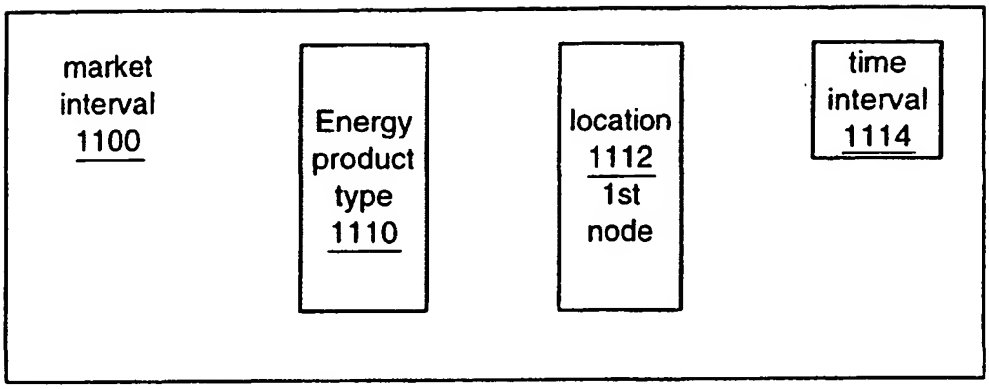


Fig. 6A

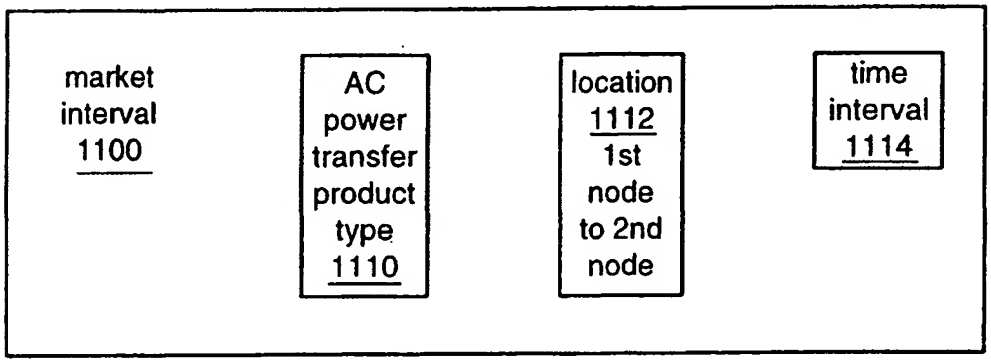


Fig. 6B

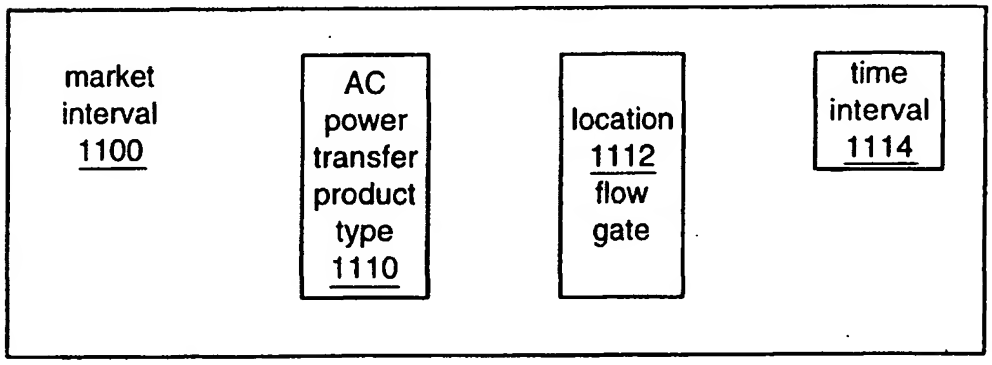


Fig. 6C

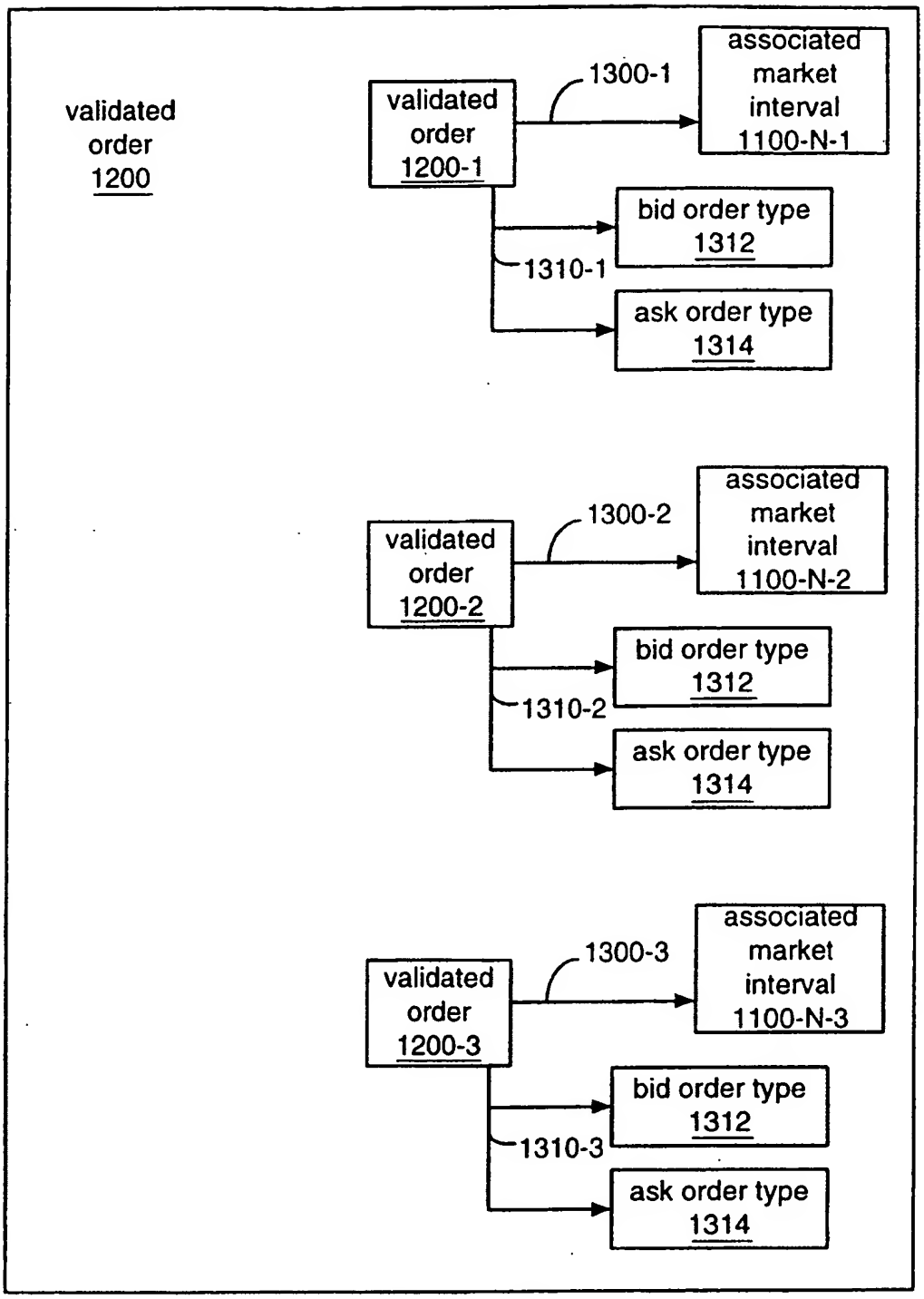

validated order 1200
validated order 1200-1
1300-1
associated market interval 1100-N-1
bid order type 1312
1310-1
ask order type 1314
validated order 1200-2
1300-2
associated market interval 1100-N-2
bid order type 1312
1310-2
ask order type 1314
validated order 1200-3
1300-3
associated market interval 1100-N-3
bid order type 1312
1310-3
ask order type 1314

Fig. 7

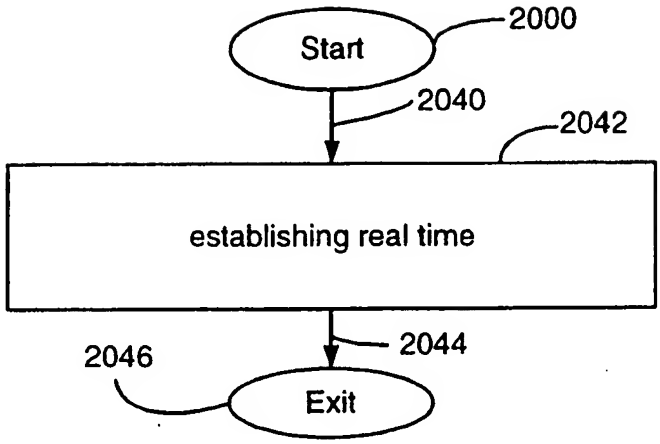

Start
2000
2040
2042
establishing real time
2044
2046
Exit

Fig. 9A

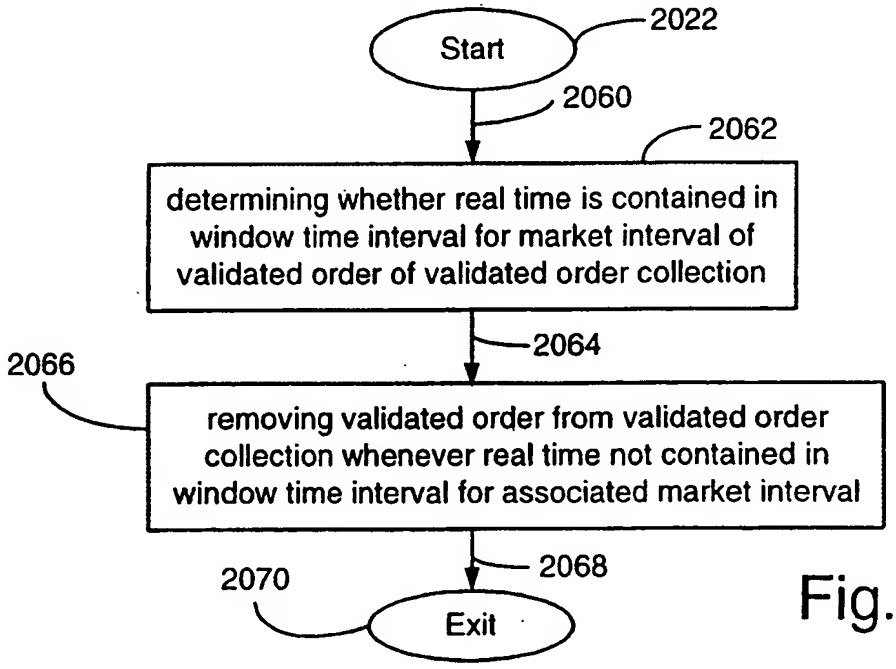

Start
2022
2060
2062
determining whether real time is contained in window time interval for market interval of validated order of validated order collection
2064
2066
removing validated order from validated order collection whenever real time not contained in window time interval for associated market interval
2068
2070
Exit

Fig. 9B

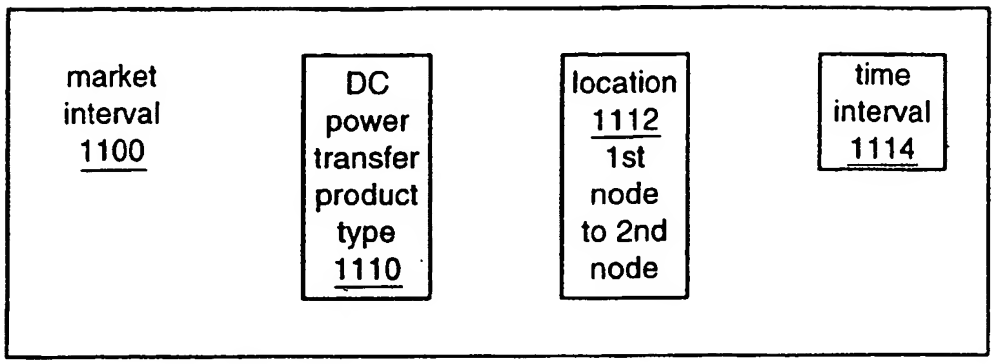


Fig. 8A

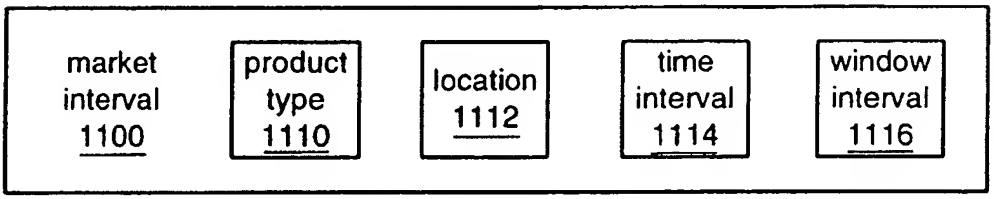


Fig. 8B

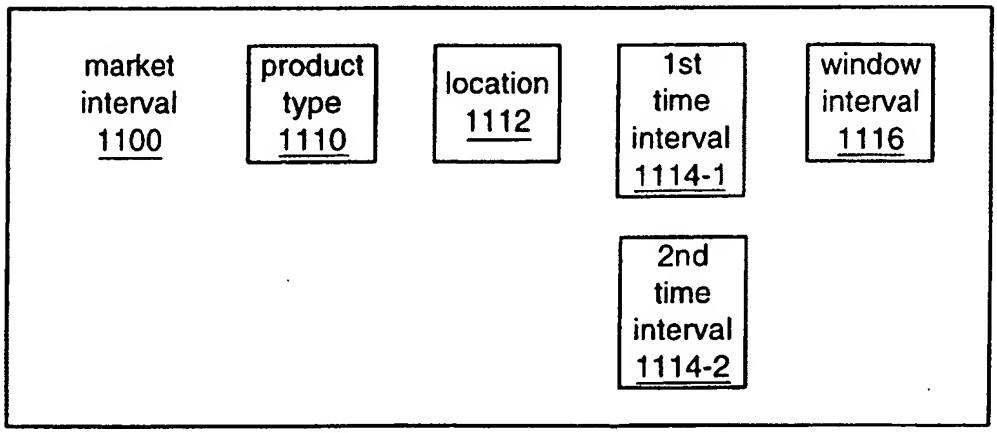


Fig. 8C

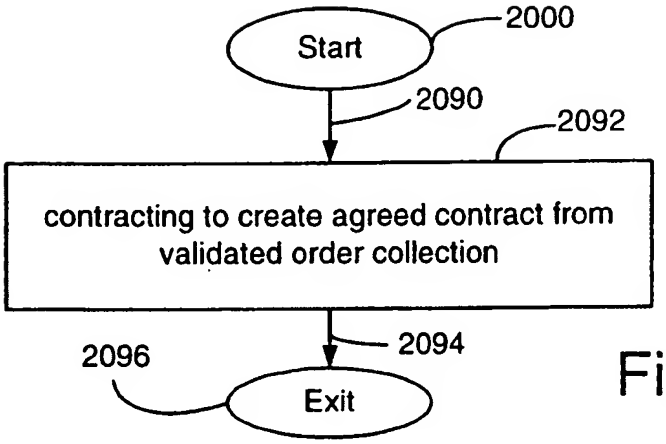


Fig. 10A

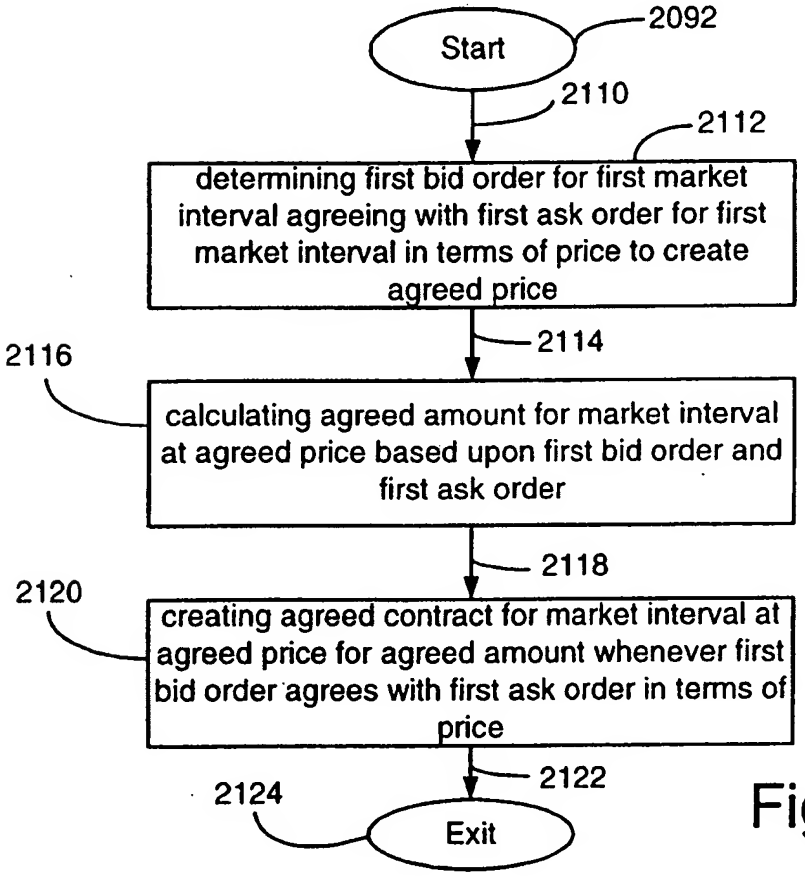


Fig. 10B

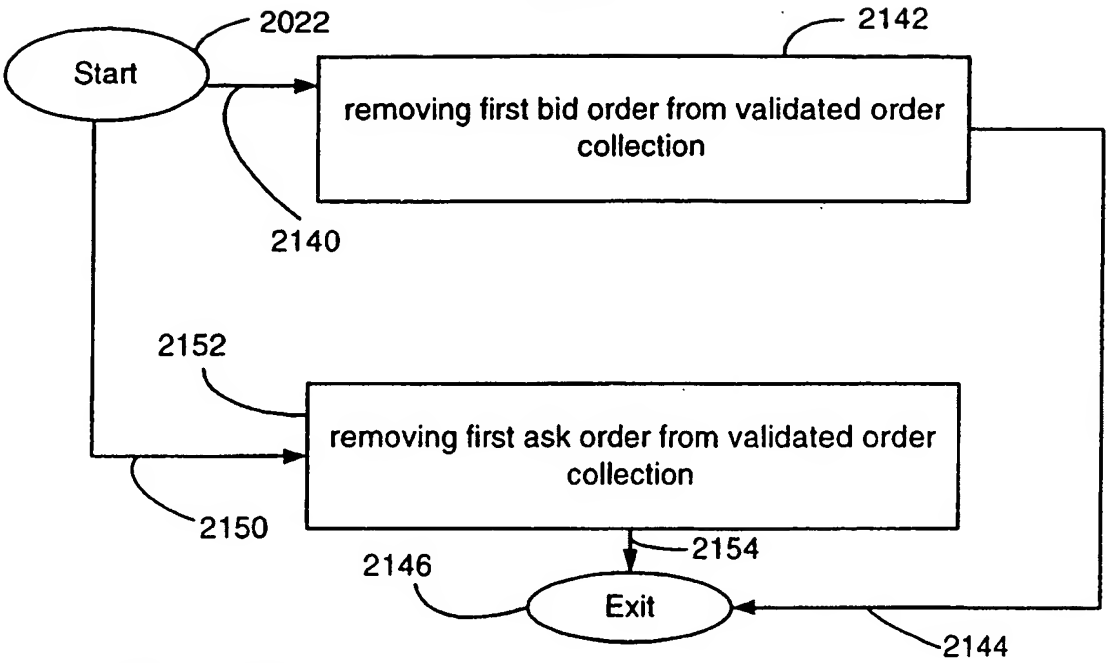


Fig. 11A

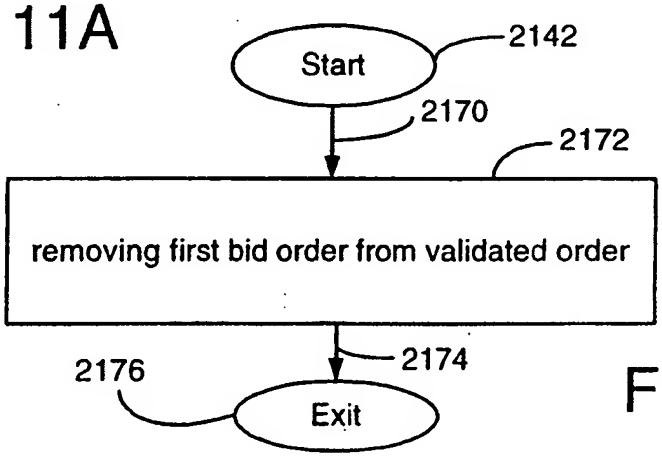


Fig. 11B

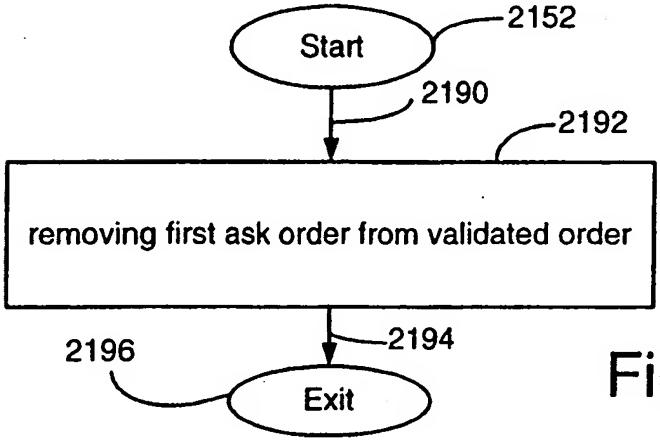


Fig. 11C

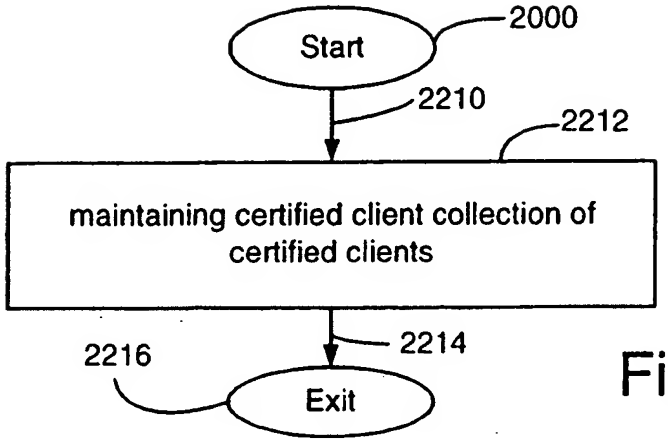


Fig. 12A

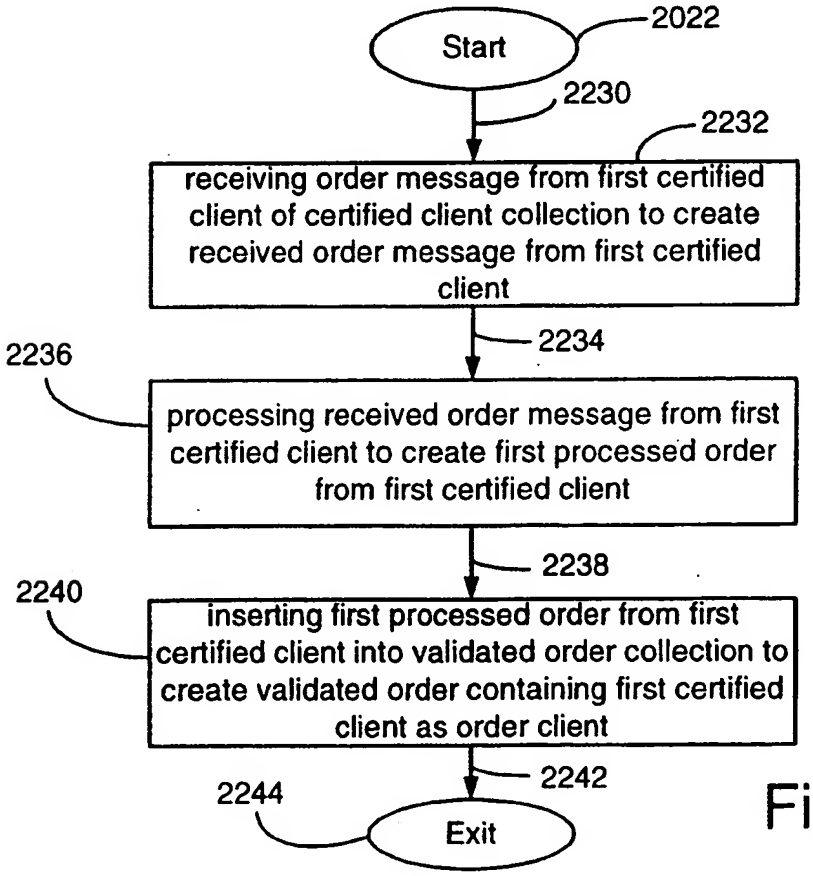


Fig. 12B

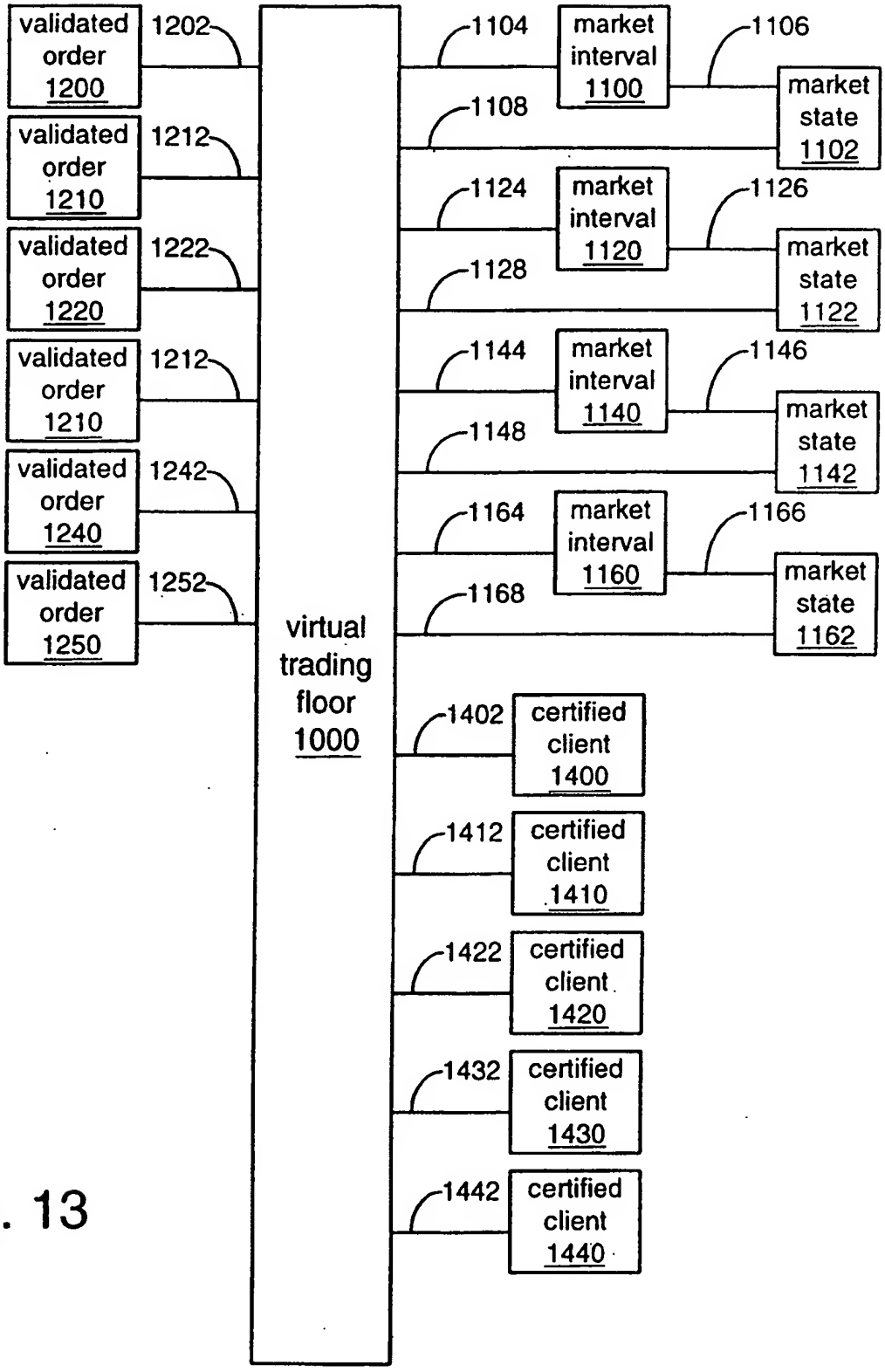

validated order 1200
1202
validated order 1210
1212
validated order 1220
1222
validated order 1210
1212
validated order 1240
1242
validated order 1250
1252
virtual trading floor 1000
1104
market interval 1100
1106
market state 1102
1108
1124
market interval 1120
1126
market state 1122
1128
1144
market interval 1140
1146
market state 1142
1148
1164
market interval 1160
1166
market state 1162
1168
1402
certified client 1400
1412
certified client 1410
1422
certified client 1420
1432
certified client 1430
1442
certified client 1440

Fig. 13

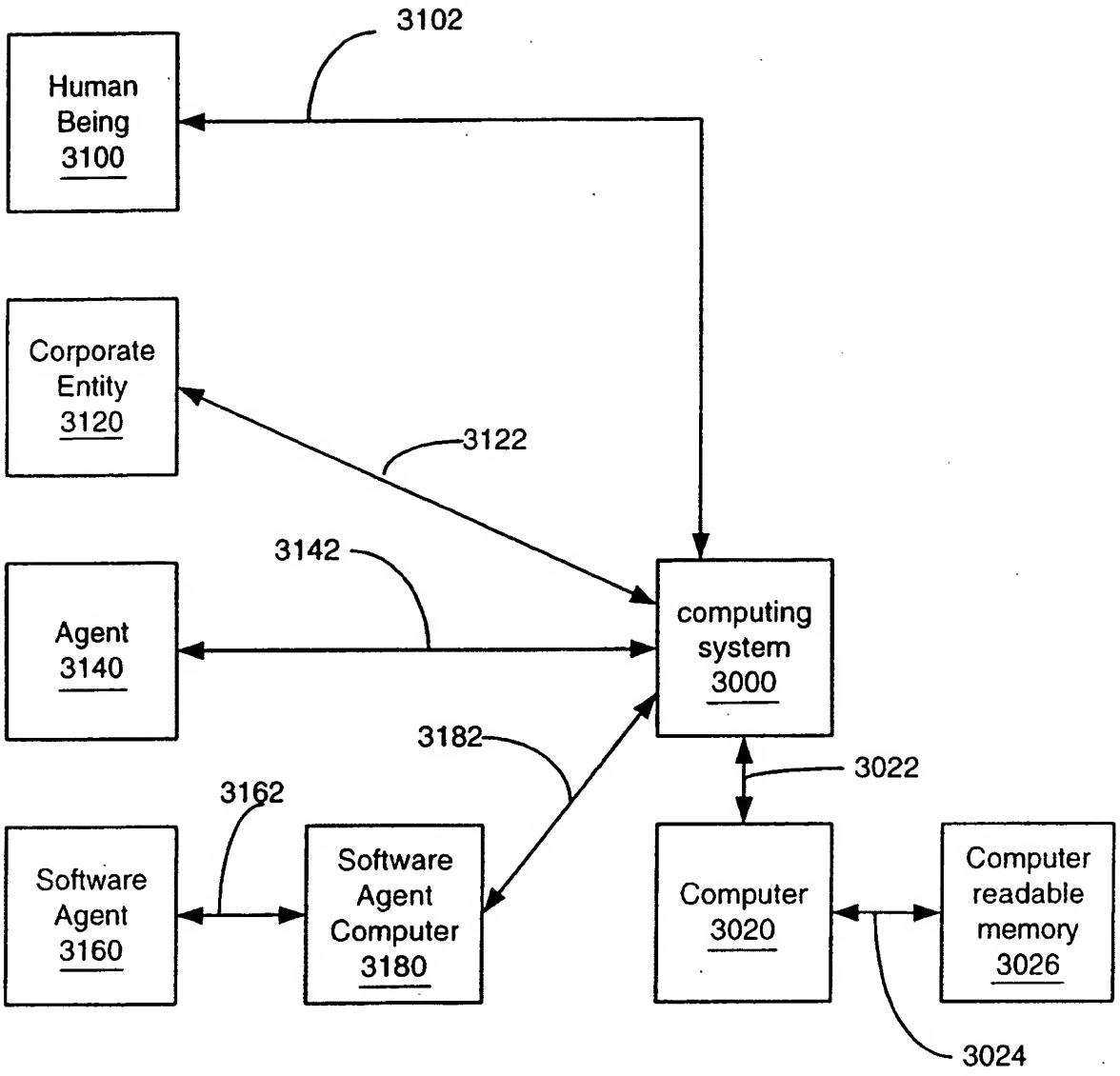

3102
Human Being 3100
Corporate Entity 3120
3122
3142
Agent 3140
computing system 3000
3182
3022
3162
Software Agent 3160
Software Agent Computer 3180
Computer 3020
Computer readable memory 3026
3024

Fig. 14

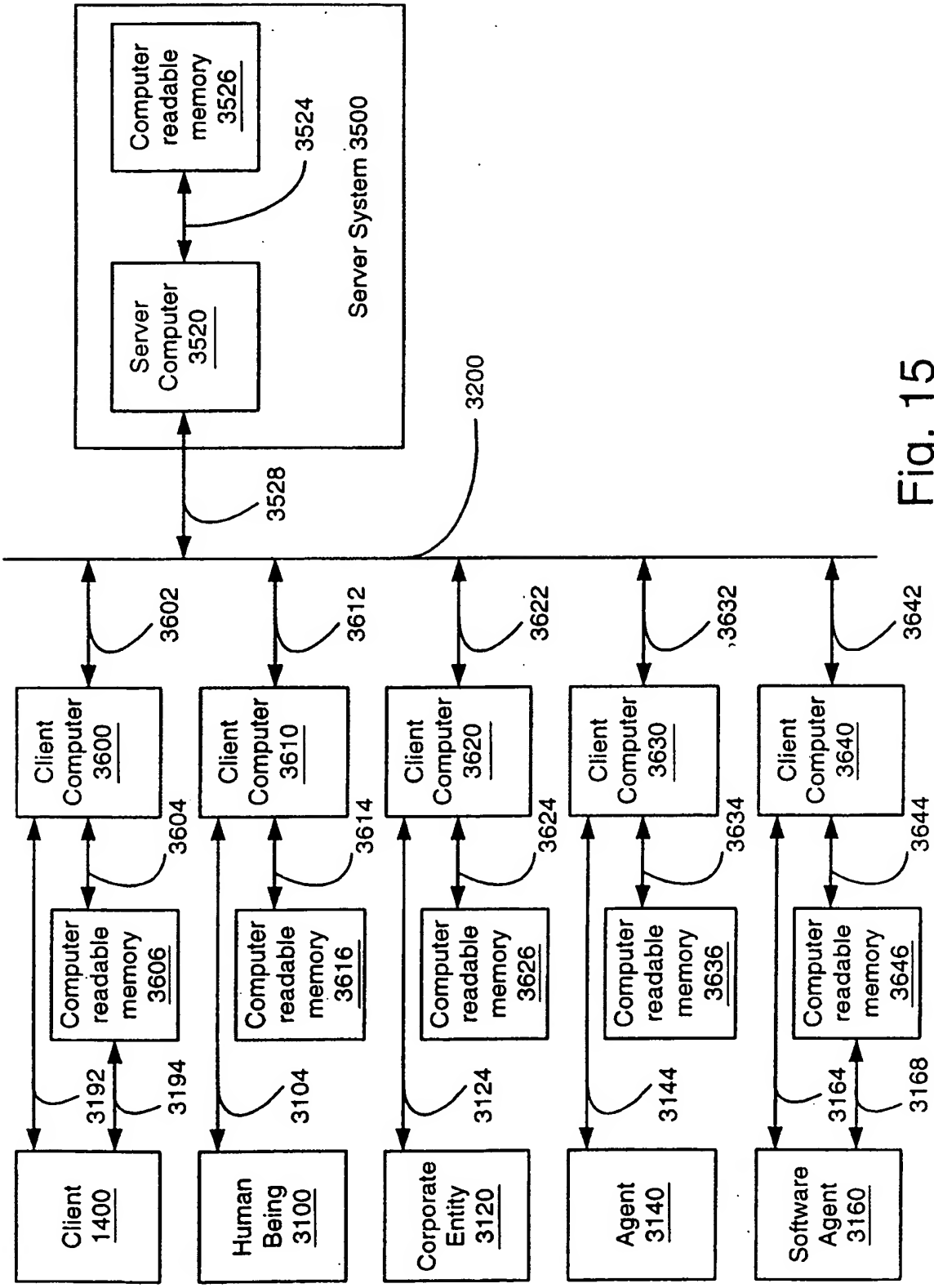

Server System 3500
Computer readable memory 3526
3524
Server Computer 3520
3528
3200
3602
3612
3622
3632
3642
Client Computer 3600
Client Computer 3610
Client Computer 3620
Client Computer 3630
Client Computer 3640
3604
3614
3624
3634
3644
Computer readable memory 3606
Computer readable memory 3616
Computer readable memory 3626
Computer readable memory 3636
Computer readable memory 3646
3192
3194
3104
3124
3144
3164
3168
Client 1400
Human Being 3100
Corporate Entity 3120
Agent 3140
Software Agent 3160

Fig. 15

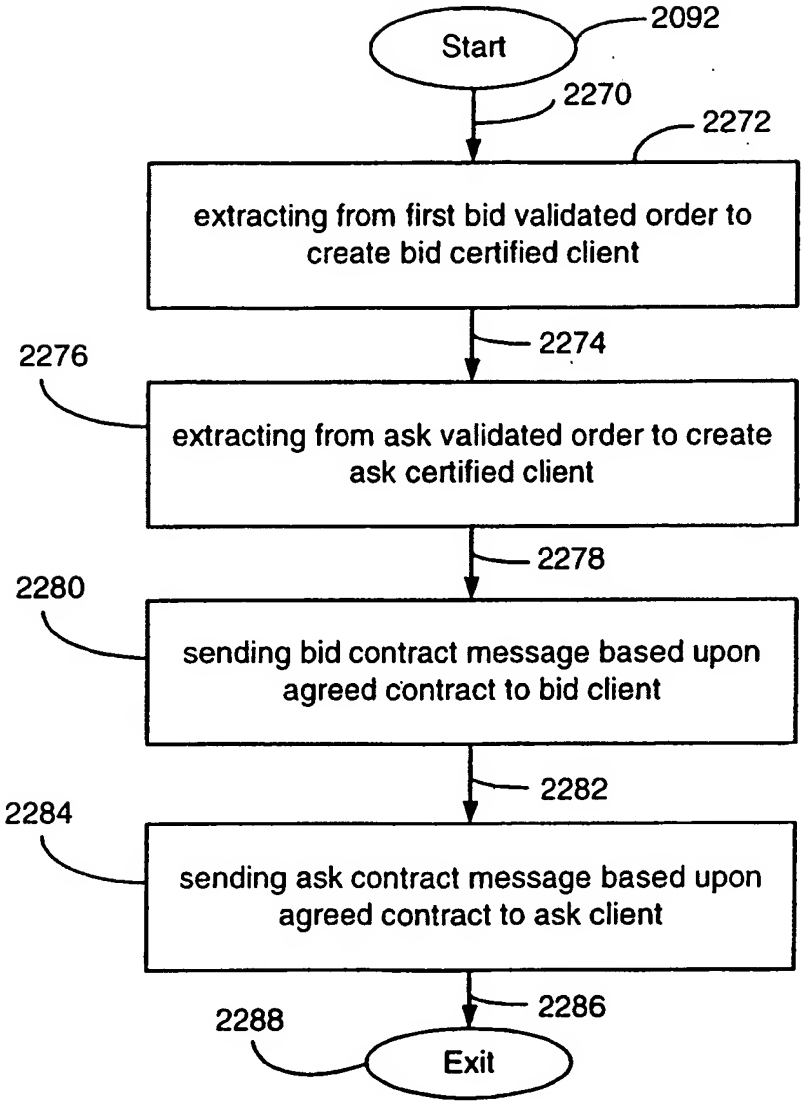

Start
2092
2270
2272
extracting from first bid validated order to create bid certified client
2274
2276
extracting from ask validated order to create ask certified client
2278
2280
sending bid contract message based upon agreed contract to bid client
2282
2284
sending ask contract message based upon agreed contract to ask client
2286
2288
Exit

Fig. 16

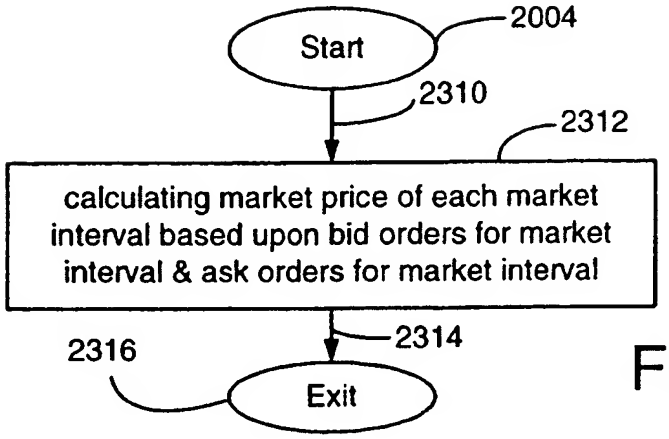


Fig. 17A

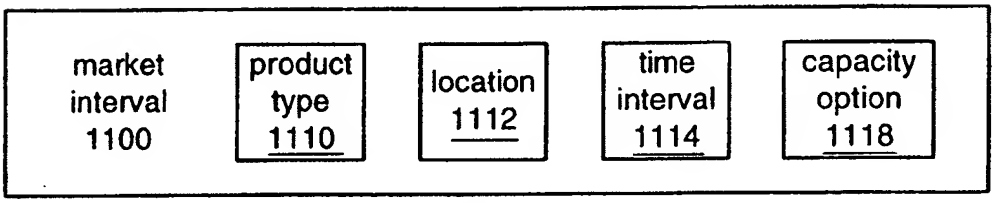


Fig. 17B

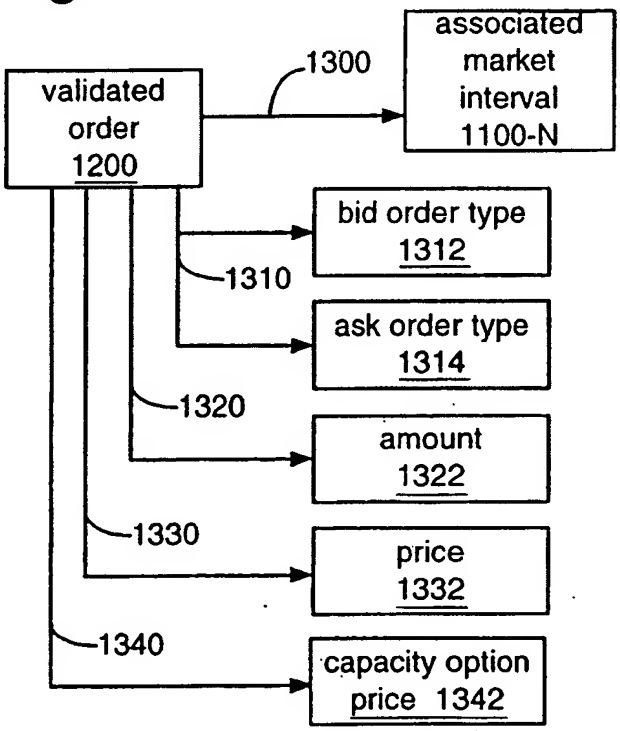


Fig. 17C

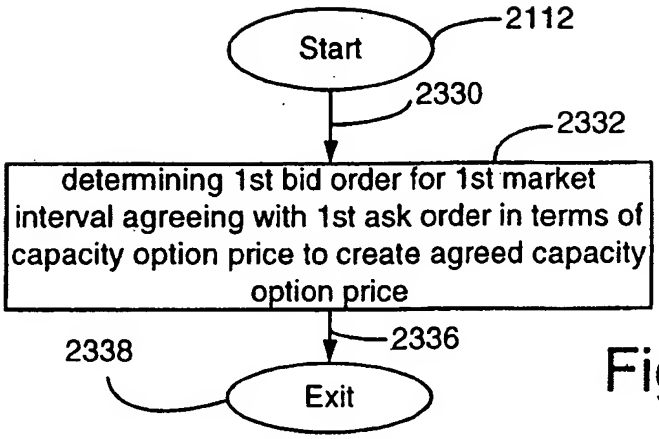


Fig. 18A

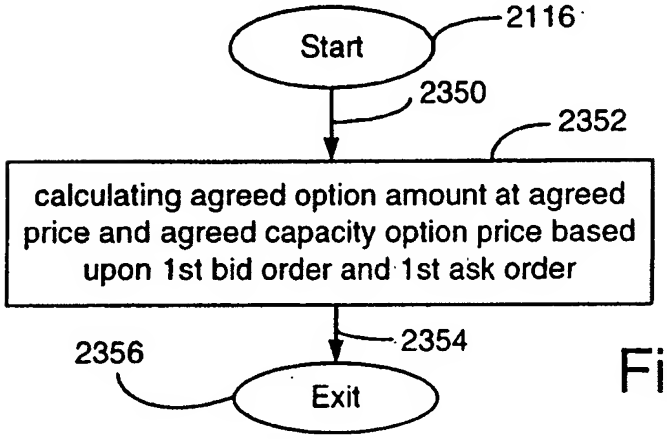


Fig. 18B

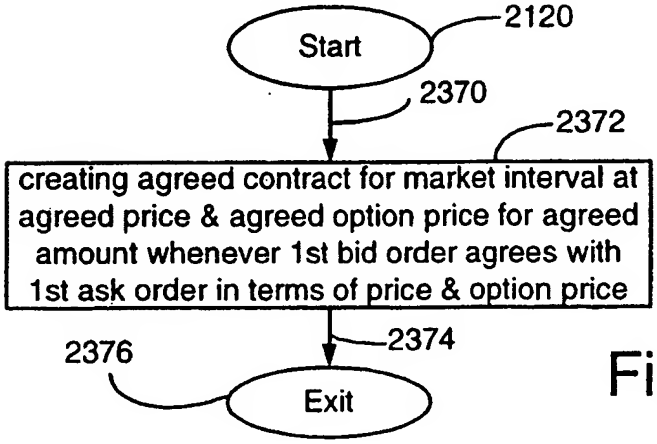


Fig. 18C

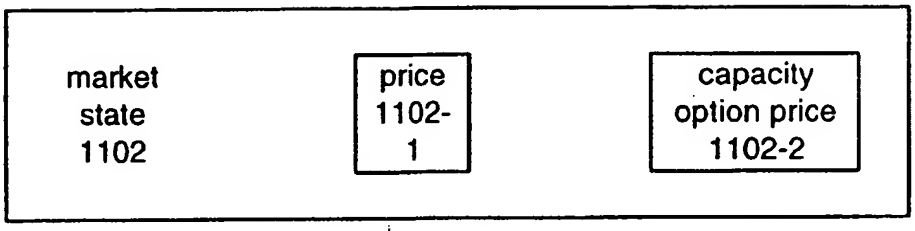


Fig. 19A

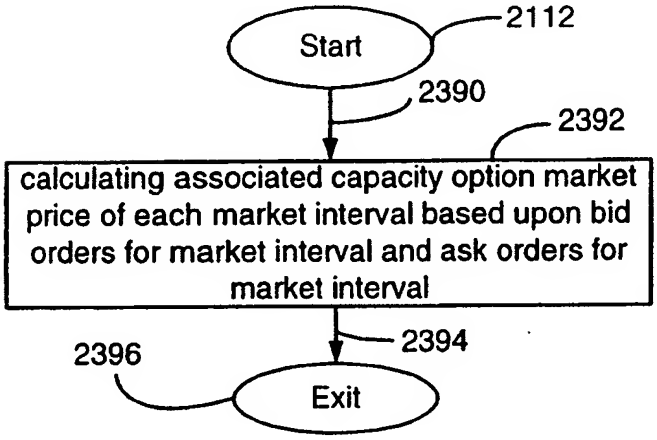
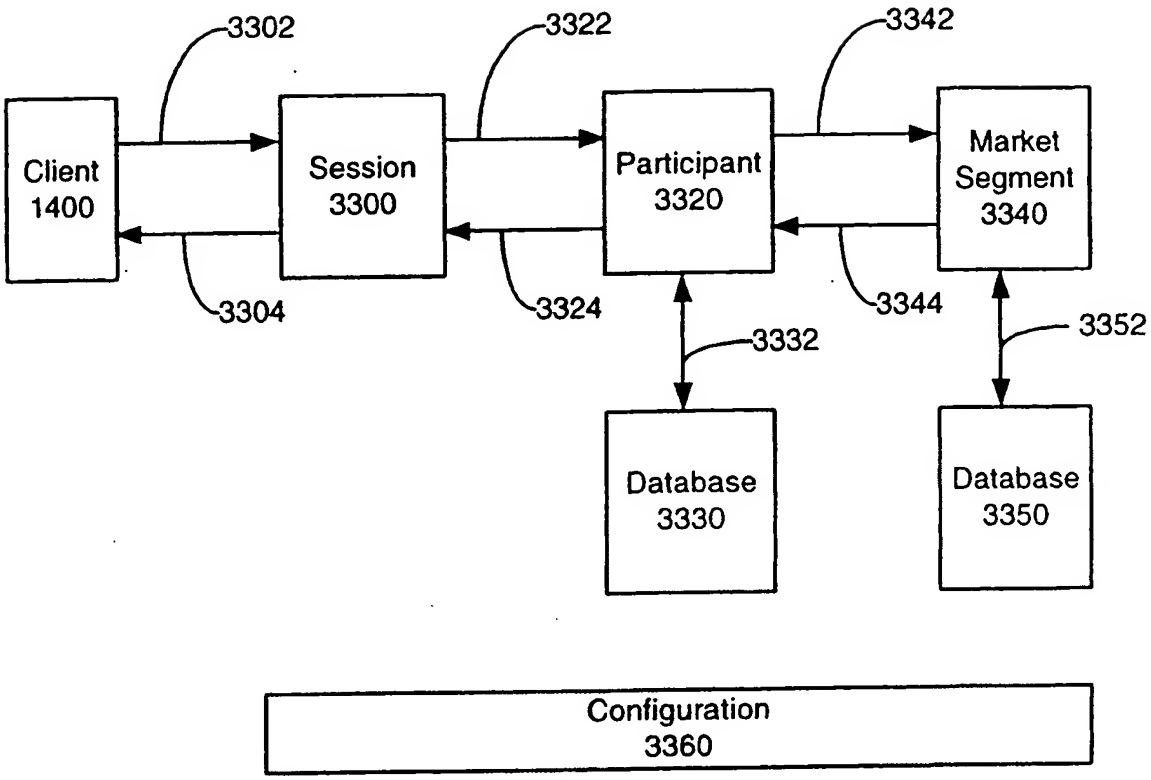


Fig. 19B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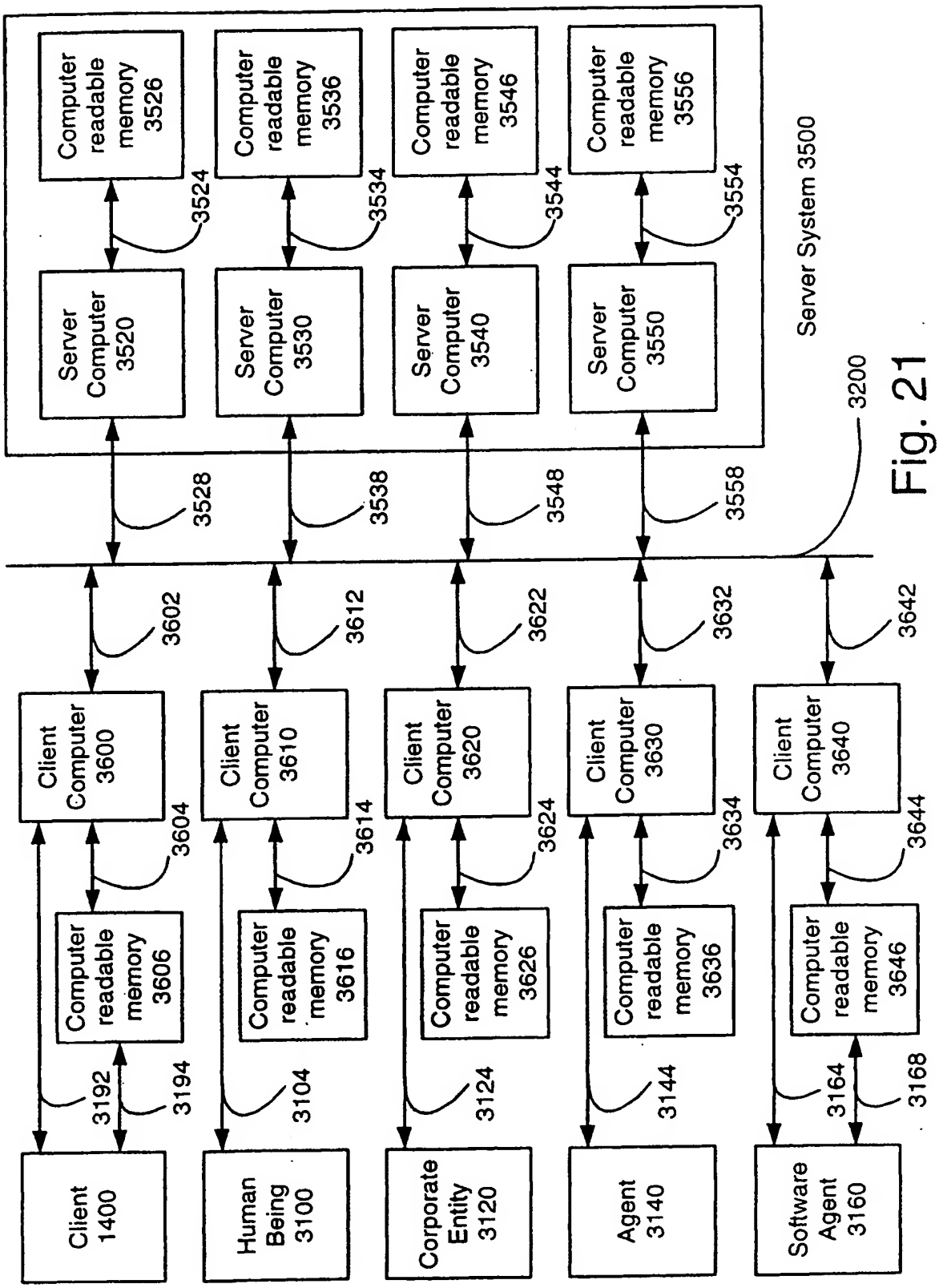
3322
3342
Client
1400
Session
3300
Participant
3320
Market
Segment
3340
3304
3324
3344
3352
3332
Database
3330
Database
3350
Configuration
3360

Fig. 20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Computer readable memory 3526
Computer readable memory 3536
Computer readable memory 3546
Computer readable memory 3556
Server Computer 3520
Server Computer 3530
Server Computer 3540
Server Computer 3550
3524
3534
3544
3554
3528
3538
3548
3558
3200
3602
3612
3622
3632
3642
Client Computer 3600
Client Computer 3610
Client Computer 3620
Client Computer 3630
Client Computer 3640
3604
3614
3624
3634
3644
Computer readable memory 3606
Computer readable memory 3616
Computer readable memory 3626
Computer readable memory 3636
Computer readable memory 3646
3192
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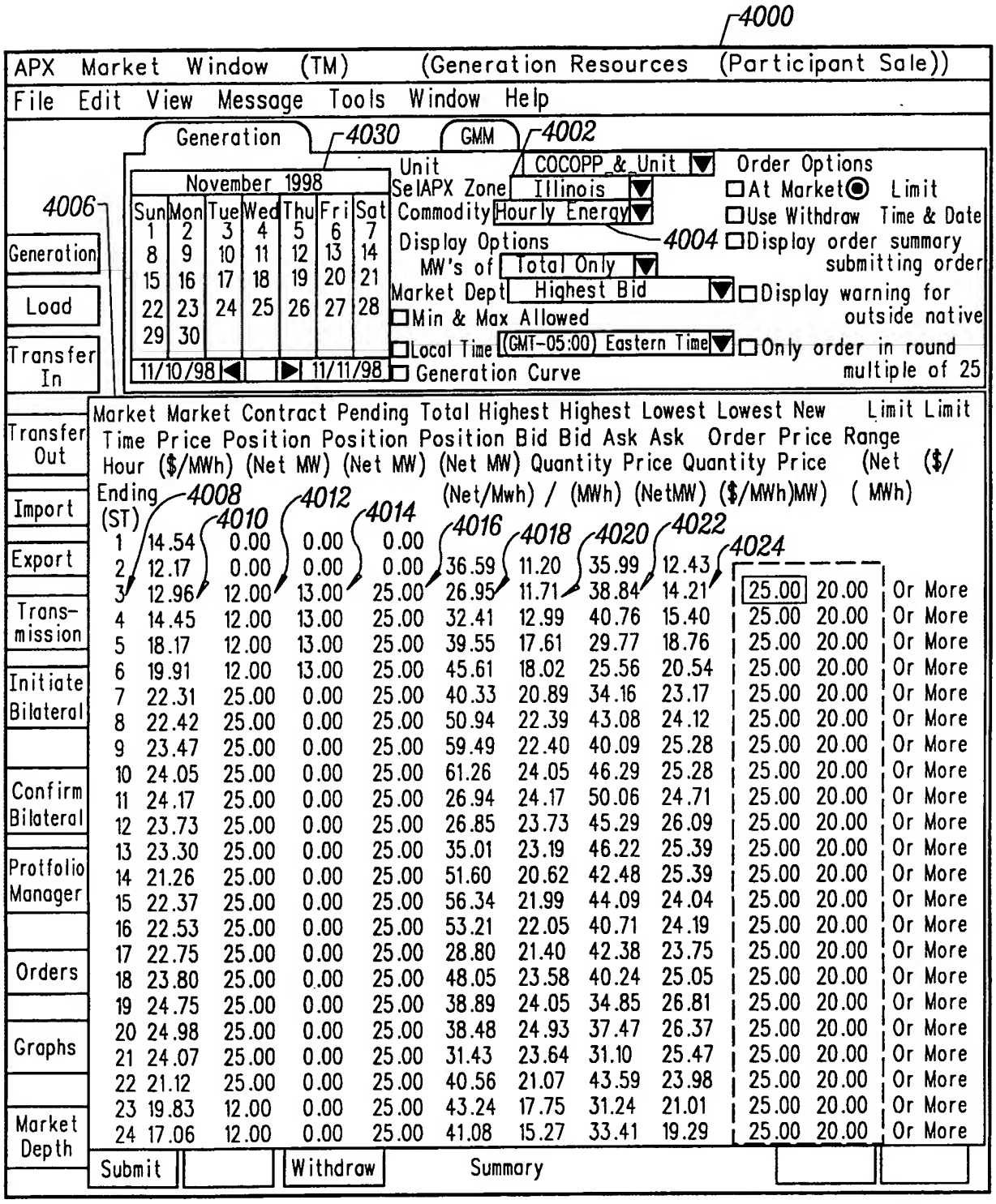
3104
3124
3144
3164
3168
Client 1400
Human Being 3100
Corporate Entity 3120
Agent 3140
Software Agent 3160

Fig. 21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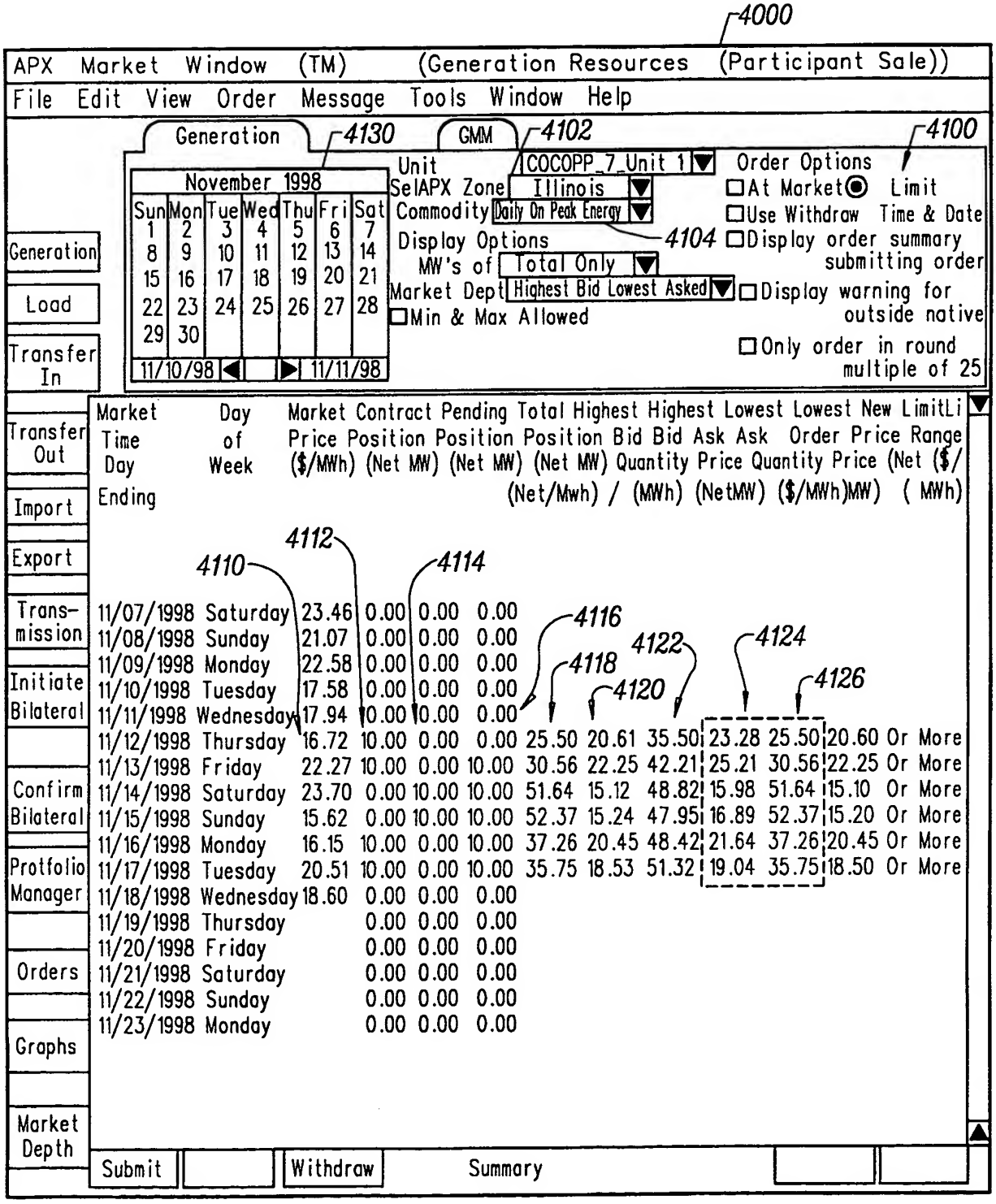
APX Market Window (TM) (Generation Resources (Participant Sale))
File Edit View Message Tools Window Help
Generation
4030
GMM
4002
November 1998
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
11/10/98
11/11/98
Unit COCOPP_&_Unit
Sel APX Zone Illinois
Commodity Hourly Energy
4004
Display Options
MW's of Total Only
Market Dept Highest Bid
Min & Max Allowed
Local Time (GMT-05:00) Eastern Time
Generation Curve
Order Options
At Market Limit
Use Withdraw Time & Date
Display order summary submitting order
Display warning for outside native
Only order in round multiple of 25
4006
Generation
Load
Transfer In
Transfer Out
Import
Export
Trans-mission
Initiate Bilateral
Confirm Bilateral
Protfolio Manager
Orders
Graphs
Market Depth
Market Time Hour Ending (ST)
Market Price ($/MWh)
Contract Position (Net MW)
Pending Position (Net MW)
Total Position (Net MW)
Highest Bid Quantity (Net/Mwh)
Highest Bid Price ($/MWh)
Lowest Ask Quantity (MWh)
Lowest Ask Price (NetMW)
New Order ($/MWh)MW)
Limit Price Range (Net MWh)
4008
4010
4012
4014
4016
4018
4020
4022
4024
1 14.54 0.00 0.00 0.00
2 12.17 0.00 0.00 0.00 36.59 11.20 35.99 12.43
3 12.96 12.00 13.00 25.00 26.95 11.71 38.84 14.21 25.00 20.00 Or More
4 14.45 12.00 13.00 25.00 32.41 12.99 40.76 15.40 25.00 20.00 Or More
5 18.17 12.00 13.00 25.00 39.55 17.61 29.77 18.76 25.00 20.00 Or More
6 19.91 12.00 13.00 25.00 45.61 18.02 25.56 20.54 25.00 20.00 Or More
7 22.31 25.00 0.00 25.00 40.33 20.89 34.16 23.17 25.00 20.00 Or More
8 22.42 25.00 0.00 25.00 50.94 22.39 43.08 24.12 25.00 20.00 Or More
9 23.47 25.00 0.00 25.00 59.49 22.40 40.09 25.28 25.00 20.00 Or More
10 24.05 25.00 0.00 25.00 61.26 24.05 46.29 25.28 25.00 20.00 Or More
11 24.17 25.00 0.00 25.00 26.94 24.17 50.06 24.71 25.00 20.00 Or More
12 23.73 25.00 0.00 25.00 26.85 23.73 45.29 26.09 25.00 20.00 Or More
13 23.30 25.00 0.00 25.00 35.01 23.19 46.22 25.39 25.00 20.00 Or More
14 21.26 25.00 0.00 25.00 51.60 20.62 42.48 25.39 25.00 20.00 Or More
15 22.37 25.00 0.00 25.00 56.34 21.99 44.09 24.04 25.00 20.00 Or More
16 22.53 25.00 0.00 25.00 53.21 22.05 40.71 24.19 25.00 20.00 Or More
17 22.75 25.00 0.00 25.00 28.80 21.40 42.38 23.75 25.00 20.00 Or More
18 23.80 25.00 0.00 25.00 48.05 23.58 40.24 25.05 25.00 20.00 Or More
19 24.75 25.00 0.00 25.00 38.89 24.05 34.85 26.81 25.00 20.00 Or More
20 24.98 25.00 0.00 25.00 38.48 24.93 37.47 26.37 25.00 20.00 Or More
21 24.07 25.00 0.00 25.00 31.43 23.64 31.10 25.47 25.00 20.00 Or More
22 21.12 25.00 0.00 25.00 40.56 21.07 43.59 23.98 25.00 20.00 Or More
23 19.83 12.00 0.00 25.00 43.24 17.75 31.24 21.01 25.00 20.00 Or More
24 17.06 12.00 0.00 25.00 41.08 15.27 33.41 19.29 25.00 20.00 Or More
Submit
Withdraw
Summary

Fig. 22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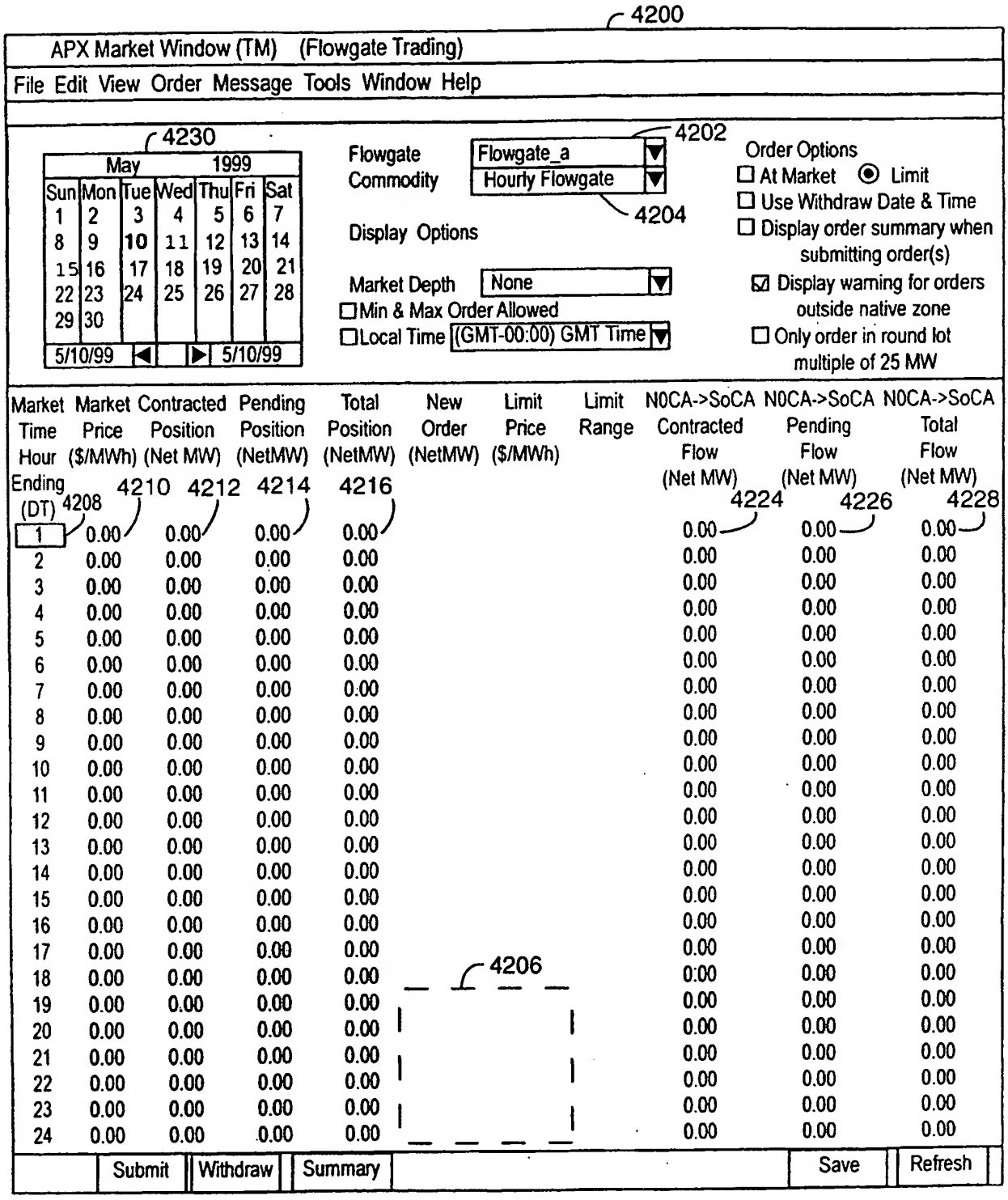
File Edit View Order Message Tools Window Help
Generation
Load
Transfer In
Transfer Out
Import
Export
Trans-mission
Initiate Bilateral
Confirm Bilateral
Protfolio Manager
Orders
Graphs
Market Depth
Generation
GMM
4130
4102
4100
November 1998
Sun Mon Tue Wed Thu Fri Sat
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
11/10/98
11/11/98
Unit
SelAPX Zone Illinois
Commodity Daily On Peak Energy
Display Options
4104
MW's of Total Only
Market Dept Highest Bid Lowest Asked
Min & Max Allowed
COCOPP_7_Unit 1
Order Options
At Market Limit
Use Withdraw Time & Date
Display order summary submitting order
Display warning for outside native
Only order in round multiple of 25
Market Time Day Ending
Day of Week
Market Price ($/MWh)
Contract Position (Net MW)
Pending Position (Net MW)
Total Position (Net MW)
Highest Bid Quantity (Net/Mwh)
Highest Bid Price ($/MWh)
Lowest Ask Quantity (MWh)
Lowest Ask Price (NetMW)
Lowest Ask ($/MWh)
New Order (MW)
Limit Price Range (Net ($/MWh)
4110
4112
4114
4116
4118
4120
4122
4124
4126
11/07/1998 Saturday 23.46 0.00 0.00 0.00
11/08/1998 Sunday 21.07 0.00 0.00 0.00
11/09/1998 Monday 22.58 0.00 0.00 0.00
11/10/1998 Tuesday 17.58 0.00 0.00 0.00
11/11/1998 Wednesday 17.94 0.00 0.00 0.00
11/12/1998 Thursday 16.72 10.00 0.00 0.00 25.50 20.61 35.50 23.28 25.50 20.60 Or More
11/13/1998 Friday 22.27 10.00 0.00 10.00 30.56 22.25 42.21 25.21 30.56 22.25 Or More
11/14/1998 Saturday 23.70 0.00 10.00 10.00 51.64 15.12 48.82 15.98 51.64 15.10 Or More
11/15/1998 Sunday 15.62 0.00 10.00 10.00 52.37 15.24 47.95 16.89 52.37 15.20 Or More
11/16/1998 Monday 16.15 10.00 0.00 10.00 37.26 20.45 48.42 21.64 37.26 20.45 Or More
11/17/1998 Tuesday 20.51 10.00 0.00 10.00 35.75 18.53 51.32 19.04 35.75 18.50 Or More
11/18/1998 Wednesday 18.60 0.00 0.00 0.00
11/19/1998 Thursday 0.00 0.00 0.00
11/20/1998 Friday 0.00 0.00 0.00
11/21/1998 Saturday 0.00 0.00 0.00
11/22/1998 Sunday 0.00 0.00 0.00
11/23/1998 Monday 0.00 0.00 0.00
Submit
Withdraw
Summary

Fig. 23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APX Market Window (TM) (Flowgate Trading)
File Edit View Order Message Tools Window Help
4230
May 1999
Sun Mon Tue Wed Thu Fri Sat
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8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
5/10/99
5/10/99
Flowgate
Commodity
Flowgate_a
Hourly Flowgate
4202
4204
Display Options
Market Depth
None
Min & Max Order Allowed
Local Time
(GMT-00:00) GMT Time
Order Options
At Market
Limit
Use Withdraw Date & Time
Display order summary when submitting order(s)
Display warning for orders outside native zone
Only order in round lot multiple of 25 MW
Market Time Hour Ending (DT)
Market Price ($/MWh)
Contracted Position (Net MW)
Pending Position (NetMW)
Total Position (NetMW)
New Order (NetMW)
Limit Price ($/MWh)
Limit Range
N0CA->SoCA Contracted Flow (Net MW)
N0CA->SoCA Pending Flow (Net MW)
N0CA->SoCA Total Flow (Net MW)
4208
4210
4212
4214
4216
4224
4226
4228
4206
Submit
Withdraw
Summary
Save
Refresh

Fig. 24

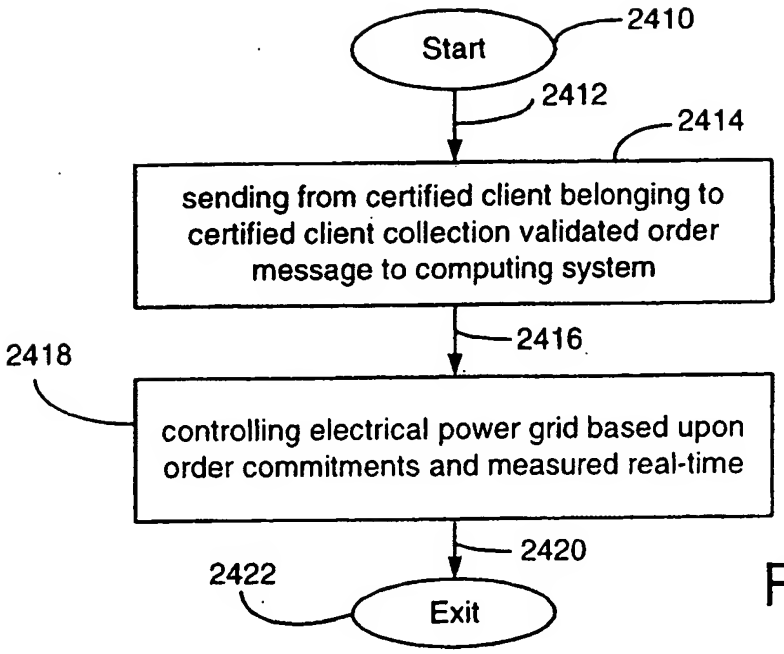
Start
2410
2412
2414
sending from certified client belonging to certified client collection validated order message to computing system
2416
2418
controlling electrical power grid based upon order commitments and measured real-time
2420
2422
Exit

Fig. 25

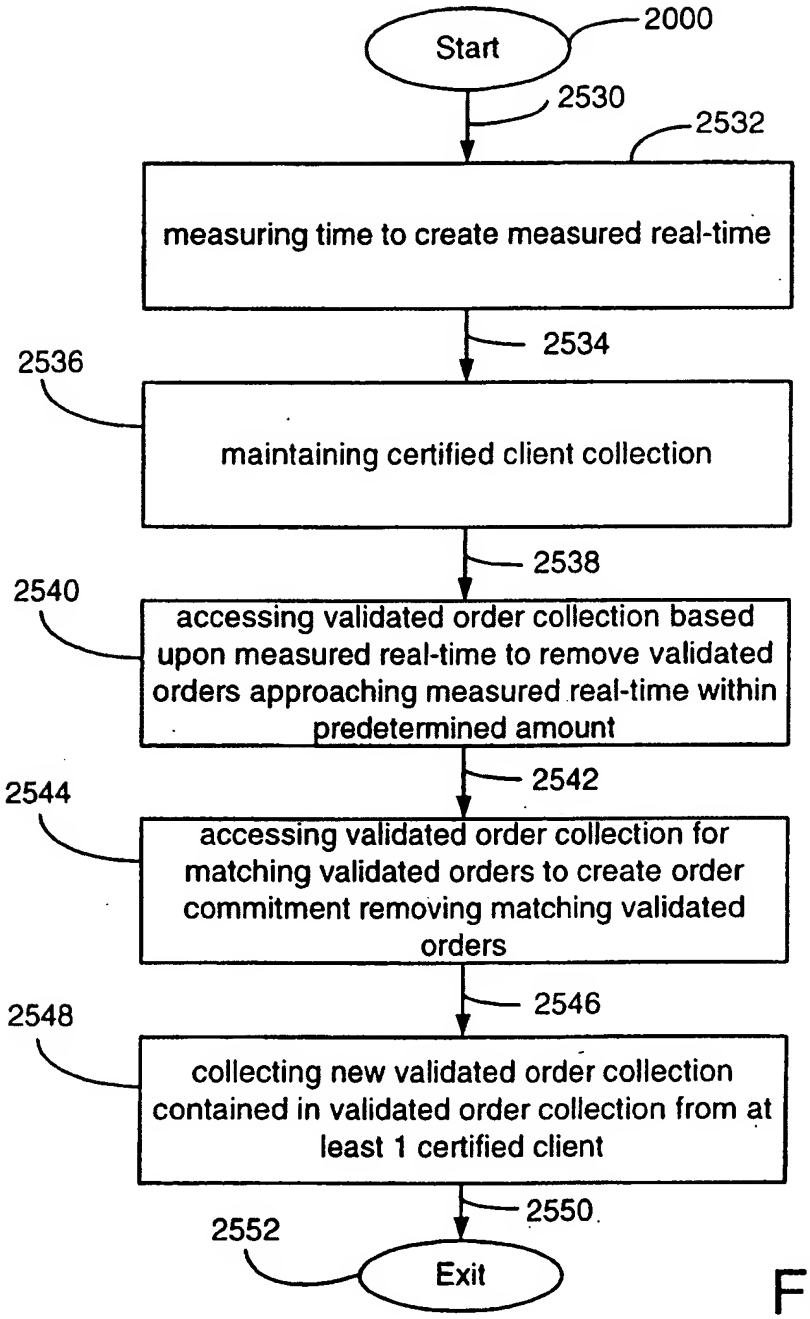
Start
2000
2530
2532
measuring time to create measured real-time
2534
2536
maintaining certified client collection
2538
2540
accessing validated order collection based upon measured real-time to remove validated orders approaching measured real-time within predetermined amount
2542
2544
accessing validated order collection for matching validated orders to create order commitment removing matching validated orders
2546
2548
collecting new validated order collection contained in validated order collection from at least 1 certified client
2550
2552
Exit

Fig. 26

INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/US 00/22489

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02J3/00 G06F17/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02J G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages .	Relevant to claim No.
X	WO 98 38844 A (SUMMIT TELECOM SYSTEMS INC) 11 September 1998 (1998-09-11)	1,2,17, 18,33, 34,55,56
Y	the whole document	3,4,19, 20,35,36
X	US 5 375 055 A (DUNNE MICHAEL F ET AL) 20 December 1994 (1994-12-20)	1,2,17, 18,33, 34,55,56
	abstract column 2	

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2000	14/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Marannino, E.

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/US 00/22489

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	NERC TRANSACTION RESERVATION AND SCHEDULING SELF DIRECTED WORK TEAM: "Discussion paper on Aligning Trasmission Reservations and Energy Schedules to Actual Flows" TRS SDWT FINAL REPORT (DRAFT OF THE PART OF THE MARCH 1999 ADEQUACY AGENDA), November 1998 (1998-11), pages 1-36, XP002152290 cited in the application page 15 -page 17 ---	3,19,35
Y	EP 0 867 998 A (ASEA BROWN BOVERI) 30 September 1998 (1998-09-30) abstract ---	4,20,36
A	US 5 297 031 A (BROGAN JOHN J ET AL) 22 March 1994 (1994-03-22) abstract ---	1-56
A	GERALD B. SHEBLÉ: "Priced based operation in an auction market sructure" IEEE TRANSACTION ON POWER SYSTEMS, 'Online! vol. II, no. 4, November 1996 (1996-11), XP002153993 Retrieved from the Internet: <URL:http://IEEEXPLORE.IEEE.ORG/lpdocs/epic03/VadvSearch.htm> 'retrieved on 2000-11-20! the whole document ---	1-56
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